# The Price-rigidity Puzzle on a Micro-island

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# The Price-rigidity Puzzle on a Micro-island: The Case of Curaçao

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Contents

**LIST OF FIGURES**

**LIST OF TABLES**

# CHAPTER 1

## THE PRICE-RIGIDITY PUZZLE ON A MICRO-ISLAND

Small open economies are price takers in the world market due to their small market shares. In general, *developing* economies have little control over their export and import prices (Agenor & Montiel, 1999). Rather, their domestic prices are supposed to follow the world prices. Contrary to this expectation, prices in the commodity markets seem to be sticky on the Caribbean micro-island of Curaçao (Caribbean Centre for Money and Finance [CCMF], 2011). This finding challenges the hypothesis of price flexibility in small developing economies. The phenomenon is a puzzle and raises the question of how to account for the price rigidity in Curaçao. The prime objective of this dissertation is to explain this price-rigidity puzzle.

Markets can be affected by an unexpected disturbance, which is called a shock. Shocks may occur on a firm/sector-specific level or on a macro-level. The most common shocks at the *firm or sector-specific* level are demand, cost, and idiosyncratic shocks. Shocks at the *macro-level* can broadly be divided into demand and supply shocks. A shock in a market with a well-functioning market-clearing mechanism is followed by an instantaneous adjustment in price, quantity, or both. A failure of market-clearing is mainly caused by price rigidities (Greenwald & Stiglitz, 1989; van Bergeijk, Haffner, & Waasdorp, 1993).

Prices may adjust slowly[1] or quickly in response to a shock. Thus, the observation of price adjustments centers on their "speed" after a shock. Frequent price adjustment or a high speed to change the price corresponds to a short period between a shock and the adjustment in price. A high speed of price adjustment, implying an immediate adjustment in price *after* a

[1] The words "infrequent," "rarely," or "sluggish" are also used. Price adjustment can be full or partial.

shock, results in flexible prices, while a low speed of price adjustment, suggesting a *lag* in price adjustment after a shock, results in so-called *sticky prices*.

The concepts of sticky versus flexible prices and the duration of a price spell are presented in Figures 1.1 and 1.2. These figures represent the price trajectories of two different articles—"A" and "B"—in the same outlet during the period of $t_1 - t_2$. A price trajectory is a series of price quotes for a specific article of a particular brand observed in a specific outlet. After a shock, price adjustments may occur. The periods in a price trajectory during which the price remains unchanged are called price spells. During the $t_1 - t_2$ period, three common shocks (shocks 1, 2, and 4) to both price trajectories and one idiosyncratic shock (shock 3) to product "B" occurred.

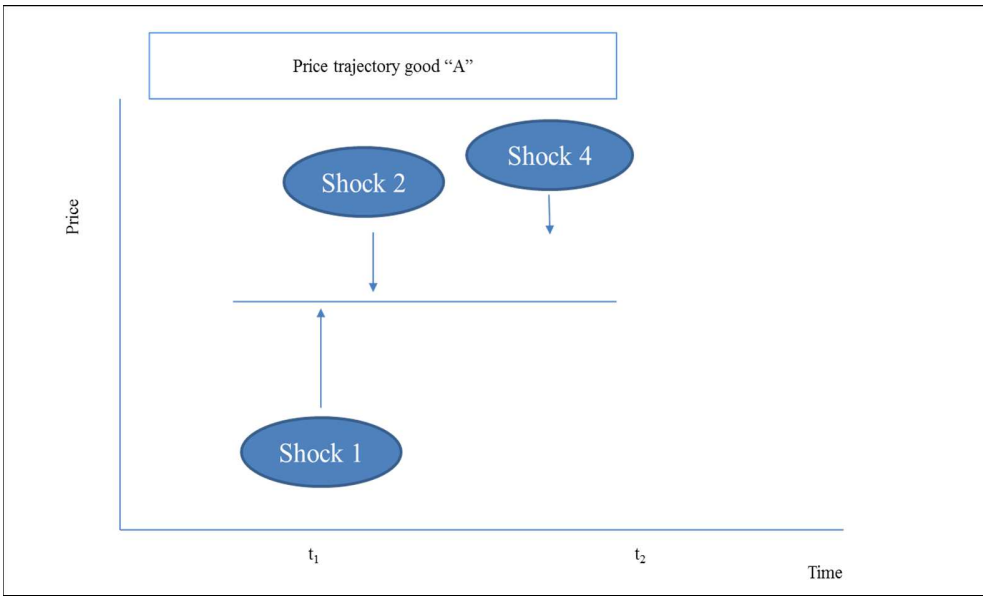


*Figure 1.1*. Price trajectory of good "A"

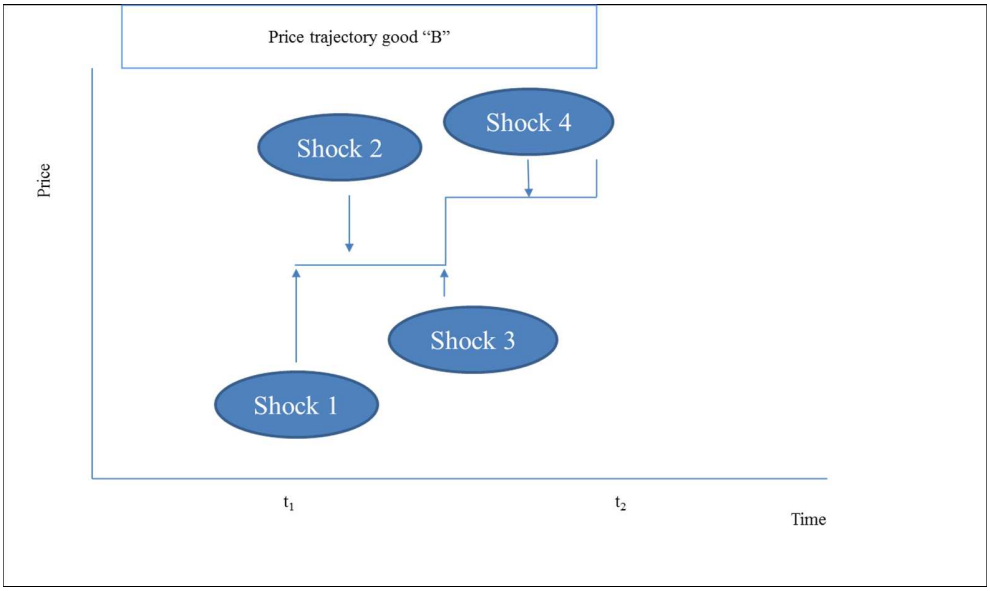


*Figure 1.2*. Price trajectory of good "B"

The price trajectory of product "A" shows that despite the shocks in the $t_1 - t_2$ period, prices remained unchanged; hence, product "A" has one price spell. The price trajectory of product "B" has two price spells, as prices changed twice in the period of $t_1 - t_2$. Hence, good "B" has a higher price change frequency than good "A." Good "B" has shorter price spells than good "A" from the periods of $t_1$ to the occurrence of shock 3 and from shock 3 to $t_2$. Thus, the price of good "B" is more "flexible" and the price of good "A" is "stickier," in the period of $t_1 - t_2$.

The speed of price adjustment is measured using either the price change frequency or the duration of price spells. The price change frequency is defined by how often prices change in a specific timeframe. Hence, the *size* of the price adjustment (full or partial) is not considered when measuring price change frequencies.

Whether a firm is able to change its price also depends on the market structure. In perfect competitive markets, firms are price takers. In this type of market structure, firms jointly adjust their given price after a shock. In contrast, each firm in an imperfect competitive or

monopolistic market can decide whether to adjust the price after a shock. When a firm keeps the prices unchanged, they may be sticky.

### 1.1. The Price Rigidity Hypotheses from a Micro-Island Perspective

The mainstream (New Keynesian) hypotheses/theories on price rigidities can be broadly categorized into the (a) menu cost, (b) staggered price, (c) sticky-information (Appendix 1A), and (d) other pricing hypotheses. The New Keynesian theories that may explain the price-rigidity puzzle in Curaçao are analyzed in this section. See Appendix 1A for an extensive analysis of the price rigidity theories that may or may not apply to Curaçao.

The *price-point* hypothesis in the category of state-dependent pricing (SDP) menu cost theories offers a plausible explanation for the sticky prices on Curaçao. *Price points* (or *attractive pricing*) occur when firms have a price strategy of setting prices ending with 9 cents, 99 cents, or 5 cents. Levy, Lee, Chen, Kauffman, and Bergen (2011) found that prices ending with "9" have a lower probability of changing than prices with non-9 endings. *Price points* with price endings at 5 (e.g., 45 cents) or 9 (e.g., 79 cents) were found for 60% of the observed prices of the database of the Central Bureau of Statistics of Curaçao consumer price quotes for Curaçao in the period of October 2006−March 2010. Hence, attractive pricing is a plausible source of price rigidity in Curaçao.

The *implicit contracts* in the staggered price hypothesis are informal, long-term agreements between firms and their customers. As each contract has its own renewal time, it causes staggered and sticky pricing. In the small and medium-sized neighborhood stores in Curaçao, the sellers know their customers and may even be on a first name basis, as their relationships have lasted a long time. This long-term customer–seller relationship may influence the frequency of changing prices, as the focus of the seller is on maintaining the old price "for

old times' sake," even in the face of a shock. Hence, the hypothesis of *implicit contracts* is likely to apply in Curaçao.

Other explanations for causes of staggered pricing are found in the *time-dependent pricing* (TDP) models (Calvo, 1983; Taylor, 1980). TDP models assume exogenous price adjustments that are independent of the state of the economy. The Taylor model assumes that firms change their prices every *n*th period, while in the Calvo model, the change in prices occurs randomly. The TDP hypothesis may apply to Curaçao, as its *regulated* prices are adjusted randomly or periodically (see Appendix 1A).

The other pricing hypotheses consist of *fair pricing*, *tacit collusion*, and the *fear of competitors' reaction.* In the *fair pricing* models (Rotemberg, 2002, 2011), firms may stabilize prices out of an obligation of "fairness" to their consumers (Rotemberg, 2011). Price increases that are caused by cost increases are perceived as fair. In contrast, price increases resulting from a rise in demand are considered unreasonable. Consequently, firms do not always change the price following a demand shock, which may lead to price rigidity. This hypothesis may apply to Curaçao, as firms in a small, close-knit community may be sensitive to the adverse publicity from antagonized customers reacting to the "unfairness" of price increases due to demand shocks.

In the hypothesis of *tacit collusion*, oligopolies "join forces" to achieve a joint maximization of profit by agreeing on the levels of price and/or output (Lipsey, Purvis, & Steiner, 1991). With the small market size of Curaçao, firms are likely to join forces and engage in tacit collusions (see Appendix 1A).

The theory of the *fear of competitors' reaction* is also known as the *kinked demand curve* (Lipsey et al., 1991). The oligopolist assumes that the competitor ignores price increases

because this will result in a loss in the price-increasing firm's market share. Moreover, the oligopolist assumes that price reductions will be matched. Fear of the competition's reaction in the oligopolistic markets of Curaçao is likely to apply, as cooperative behavior among firms in a small community will increase their joint profit maximization. Table 1.1 summarizes the price rigidity theories/hypotheses and the corresponding models that may apply to Curaçao.

Table 1.1

The Price Rigidity Theories/Hypotheses for Curaçao

| Theory/hypothesis of price rigidity | Models |
|---|---|
| 1. Menu costs hypothesis: | |
| - Attractive prices [a] | State-dependent pricing (SDP) |
| 2. Staggered pricing hypothesis: | |
| - TDP[a] | TDP |
| - Implicit contracts[b] | |
| 3. Other pricing hypotheses: | |
| - Kinked demand curve [a] | |
| - Fair pricing [b] | Fair pricing model |
| - Tacit collusion [a] | |

*Notes.*
[a.] Yes: the theory is likely to apply to Curaçao and data are available.
[b.] Yes, no data/information available: the theory is likely to apply to Curaçao, and the data to test this theory are not available for Curaçao.

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The price-rigidity theories/hypotheses of attractive pricing, TDP, implicit contracts, fear of competition's reaction (kinked-demand curve), fair pricing, and tacit collusion may explain the price rigidity in Curaçao. To test the implicit contracts hypotheses, panel data of information of the seller and the customer are necessary. For the testing of tacit collusion theory, levels of prices and outputs of all participants in the oligopolistic markets are required. For fair pricing, a survey of consumers on fair pricing is needed. The theories/hypotheses that can be tested using the available data are as follows: attractive pricing, TDP, tacit collusion, and the fear of competitors' reaction.

## 1.2. The Political Interference Hypothesis from a Micro-Island Perspective

In addition to the previous price-rigidity theories, which are market-based, market intervention by the government may also lead to price rigidity. The concept of political interference in this dissertation refers to *government intervention in the price setting* of commodities. I discuss the impact of three forms of political interference abstracted from the field of political science on the price setting in a micro-island. The three forms are: *price regulation* (Peltzman, 1993), *political business cycle* (Schuknecht, 1996), and *regulatory capture* (Dal Bo, 2006; Peltzman, 1976; Shapiro, 2012).

Price regulation was introduced in the 1960s in Curaçao based on incomes and anti-inflationary policies (P. B. No. 117, 1961). Regulated prices are changed are changed at random, or periodically (De Minister van Financien, 2015). These regulated price changes are time-dependent, which may cause sticky prices (see Appendix 1B).

According to the *political business cycle* theory, the political party in power takes only those decisions that favor their re-election (Schuknecht, 1996). Similarly, decisions that would be unpopular, such as price increases in the regulated energy sector, are not made in the immediate pre-election periods in Curaçao. Price increases in the energy sector are perceived as a deal-breaker for an upcoming election. A price decline in the energy sector, in contrast, is expected to be supported by the electorate. Therefore, in pre-election periods in Curaçao, it is unlikely that the international energy price increases will lead to domestic energy price increases. However, international energy price declines in the pre-election period most probably will be passed on to residents of Curaçao. Over the long term, such a phenomenon may have resulted in prices remaining unchanged for an extended period in pre-election times.

*Regulatory capture*[2] is the "process through which special interests affect state intervention in any of its forms" (Dal Bo, 2006, p. 203). An example of regulatory capture can be seen in the energy sector in Curaçao. In 2005, the interest groups (the consumers) in Curaçao "pressured" the government not to comply with the proposal of companies in the energy sector to increase prices following the cost increases occurred due to the international oil price hikes (*Antilliaans Dagblad*, 2005a, p. 5). In reaction, the government established the "Energy Fund" to freeze energy prices (*NRC- Handelsblad*, 2005). The regulatory authority[3] agreed with this decision (*Antilliaans Dagblad*, 2005b, p. 1). The institutionalization of the "Energy Fund" is an example of a regulatory capture, as the government was apparently influenced by the pressure of the consumers/voters and chose not to increase the energy prices. The regulatory capture may have led to a longer period of the fixed energy prices than in a regular period, which may explain the sticky energy prices.

My hypothesis is that price regulation, the political business cycle, and regulatory capture contributed to the price stickiness in Curaçao. This hypothesis might provide an additional explanation for the price-rigidity puzzle and is referred to in this dissertation as the "political interference hypothesis."

### 1.3. Outline of the Study

A micro-island is a price taker in the world economy and is assumed to have flexible domestic prices. This study demonstrates that prices are sticky in the commodity markets of one micro-island, namely Curaçao, which is a topic that has not been raised before in the economic literature. The introduction of the concept of a price-rigidity puzzle on a micro-island and the

[2] The forms of regulatory capture are described in Appendix 1B.

[3] The function of the regulatory authority in this period was assigned to the Department of Economic Affairs—the Department of Economic Affairs, "Dienst Economische Zaken," (DEZ).

explanation of this phenomenon represent the main contribution of this dissertation to the economic literature. This dissertation proposes viable theories to explain this puzzle. Additionally, sticky prices may lead to deviation from the long-run domestic prices that are measured by purchasing power parity (PPP) equilibrium. Sticky prices, therefore, may result in a rejection of the PPP hypothesis. For this reason, the impact of sticky prices on long-run equilibrium PPP value is also analyzed.

As the focus of this discussion is on price setting in the context of a Caribbean micro-island, gaining insight into the commodity markets of these islands is essential. Chapter 2 offers an introduction to factors that affected prices in the commodity markets of the Caribbean micro-islands, particularly Curaçao, in the period of 1996−2012. The methods applied in this chapter are comparative and descriptive analyses. The commodity markets are analyzed using selected indicators of the Caribbean micro-islands, and the developments of these indicators are used to provide an indication on the functioning of the Caribbean commodities' markets, particularly that of Curaçao, a micro-island with sticky prices. The analyses summarize some potential factors that might explain the price-rigidity puzzle.

Chapter 3 presents the evidence for sticky prices in Curaçao. The methods applied in this chapter are comparative analysis at the international level and sectoral analysis in Curaçao. The sample data of the comparative analysis vary considerable by country and cover the period of 1979–2010. The sectoral analysis of price adjustment in Curaçao covers the period of 2006–2010. The sectoral analysis shows which price-rigidity hypotheses are not relevant in solving the price-rigidity puzzle.

Chapter 4 applies the price-rigidity theories/hypotheses of attractive pricing, time-dependent pricing, and "political interference" to explain the price rigidity in Curaçao. The

political interference hypothesis, consisting of price regulation, the political business cycle, and regulatory capture, assumes that policymakers intervene in price setting, which may cause sticky prices. The method applied in this chapter is panel data analysis. The sample period is 2006–2010, and the data consist of the consumer price index (CPI) data, excluding the sectors/items of energy, postal services, insurance, and rents. The tests provide a partial explanation for the price rigidity in the selected sectors in Curaçao.

Chapter 5 shows that in Curaçao, the gasoline prices are sticky. As this is one of the commodity markets, its sticky prices are considered to represent a piece of the larger price-rigidity puzzle. The hypotheses of political interference, menu costs, and rational inattention are tested for the gasoline retail market of Curaçao. The method applied in this chapter is the autoregressive binomial conditional (ABC) model for the period of 1990–2012. The tests reject the menu costs and the rational inattention hypothesis in the gasoline retail market in Curaçao. In contrast, the hypothesis of political interference is supported by the data.

In Chapter 6, the impact of the sticky prices in Curaçao on the long-term PPP is analyzed. The PPP is a theoretical approach measuring the long-term behavior between the domestic price and the price of the trading partner. Sticky prices may lead to a deviation from the PPP, making its testing relevant. In addition, the impact of the high transaction costs, which is also a factor that may cause a deviation from the PPP, is analyzed. Micro-islands have high transportation costs; their impact on the relative PPP hypothesis is analyzed for a group of selected Caribbean micro-islands in this chapter. The (relative and absolute) PPP hypotheses are tested for Caribbean micro-islands—Aruba, the Bahamas, Barbados, Dominica, Saint Kitts and Nevis, Saint Lucia, and Curaçao—and their anchor country, the United States. The methods used are the linear co-integration approach and nonlinear (exponential) smooth transition autoregressive

(ESTAR) and the threshold autoregressive (TAR) models in the sample period of 1990–2012. The results show the effects of both the high transaction costs of Caribbean micro-islands and sticky prices in Curaçao on the PPP hypothesis.

Finally, Chapter 7 presents a summary of the most important findings of this research. The results show that to explain the price-rigidity puzzle in Curaçao, a hypothesis other than the price-rigidity theories is required. In addition, contrary to expectations, the sticky prices in Curaçao do not lead to a rejection of the PPP hypothesis.

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Appendix 1A: The Price Rigidity Hypotheses: The Case of Curaçao

The causes of sticky prices are explained in New Keynesian hypotheses/theories on price rigidity. These hypotheses can be broadly categorized into the (a) menu cost, (b) staggered price, (c) sticky-information (Appendix 1A), and (d) other pricing hypotheses. The most frequently applied shocks in these hypotheses involve inflation. In contrast, price declines as monetary shocks are seldom considered. The emphasis on inflation may be related to the inflationary trends in the 1970s, the period in which these theories were developed. The price rigidity theories are analyzed in terms of whether they may apply to Curaçao.

**The Menu Cost Hypothesis**

The *menu cost* of price adjustment is defined as a "small fixed cost for changing a nominal price" (Romer, 2001, p. 300). The term is derived from the cost incurred by printing restaurant's new menus. Menu costs include "(1) the labor costs of changing the shelf prices, (2) the cost of printing and delivering new price tags, (3) the costs of mistakes made during the price change process, and (4) the cost of in-store supervision of the price change process" (Levy, Bergen, Dutta, & Venable, 1997, p. 792). A broader definition of menu costs includes the "time and attention required of managers to gather relevant information and make and implement decisions" (Ball & Mankiw, 1994, pp. 24–25). The menu costs do not vary with the *size of the price change*, as the menu costs are fixed. They are modeled in the first-generation *state-dependent pricing* (SDP) models of Barro (1972), wherein the *decision* on a *contract termination* (on price) depends on the state of the economy, and is therefore determined endogenously.

In Curaçao, *menu costs* are small, as costs to change the price are not expensive. The information on the import price changes (most goods in Curaçao are imported) can be found on

the bills of import. If the retailer is not the importer of the goods, the prices will be listed on the invoice. The other costs related to price setting are mainly the costs of transportation, rental costs, and personnel cost for the shelving of goods. The information on these costs is accessible; hence, the cost of gathering information is small. In addition, the "price tags" are replaced electronically in most supermarkets using the unique classification of bar codes. When the prices are not listed on the products, the consumer can retrieve the prices at the scanner machines in the supermarkets. As prices are inputted electronically in most of the medium-sized to larger firms in Curaçao, the cost of changing prices is negligible. Hence, menu costs are unlikely to be the source of the sticky prices in Curaçao, particularly with the automated price-tag facilities.

A *price plan* is a set with current and future prices; thus, it consists of a sequence of prices. A firm with a price plan faces menu costs that are not associated only with changing the current price but also with changing the entire price plan. Changing the price plan has additional menu costs related to negotiation and communication compared to a commodity without a price plan, and the prices in a price plan are expected to be stickier (Burnstein, 2006). Accordingly, price plans are useful for firms that are producers of (intermediate) goods. For this kind of producer, knowledge on future prices is important, as this allows the firm to plan ahead using this information and calculate the cost of future production. Since most imported goods in Curaçao are final goods ready to sell to consumers, there is no need for a plan concerning future prices. Hence, *price plans* are also less likely in Curaçao.

*Price points* (or *attractive pricing*) occur when firms have a price strategy of setting prices ending with 9 cents, 99 cents, or 5 cents. The support for price points as a cause of price rigidity is presented by Levy, Lee, Chen, Kauffman, and Bergen (2011). These researchers found that "9" is the most frequently used ending, and prices ending with "9" have a lower probability

of changing than prices with non-9 endings. The *price points* with price-endings at 5 (e.g., 45 cents) or 9 (e.g., 79 cents) have been found in the database of the Central Bureau of Statistics of Curaçao consumer price quotes, which may be an indication of attractive pricing as a plausible source of price rigidity in Curaçao.

**The Staggered Price Hypothesis**

Staggered price adjustment occurs when firms have unsynchronized price-settings. This happens when a fraction of firms (the *extensive margin*) change their price. This lack of coordination in price setting between firms, the coordination failure hypothesis, is reported in Blinder (1994**,** 1998) as the primary cause of price stickiness in the United States. A lack of coordination between sellers in a small community such as Curaçao would result in consumers buying from the firm that offers the best price/quality; therefore, one firm would have a larger market share than the others. Hence, cooperation of firms in price-setting is more likely and coordination failure is less likely to occur in Curaçao.

Staggered pricing is also caused by *implicit contracts*. Implicit contracts in a customer market are informal, long-term agreements between firms and their customers. As each contract has its own renewal time, it causes staggered pricing. These agreements may lead to sticky prices, as they are "a pledge of continuity of the seller's offer" (Okun, 1981, p. 169). The hypothesis of *implicit contracts* is likely to apply in Curaçao. Most sellers know their customers and even have a long-term customer–seller relationship which influences the frequency of changing prices. Hence, the implicit contracts may cause rigid prices in Curaçao.

Other causes of staggered pricing are found in the *time-dependent pricing* (TDP) models (Calvo, 1983; Taylor, 1980). Time-dependent pricing models assume exogenous price adjustments that are independent of the state of the economy. The Taylor model assumes that

firms change their prices every *n*th period, while in the Calvo model, the change in prices occurs randomly. In both models, prices remain unchanged for a period of time, and a fixed portion of firms changes the price. As not all firms change prices simultaneously, and the price changes are staggered. The time-dependent pricing hypothesis may apply to Curaçao, as its energy regulated prices are adjusted periodically.

**The Sticky-information Hypothesis**

Information costs are the costs of acquiring information (absorbing and processing) on the state of the economy (Mankiw & Reis, 2002; Reis, 2006). In *sticky-information* hypotheses, information is costly and producers have a limited capacity to process the flow of information. As a consequence, the information will spread slowly throughout the population of producers. The information arrives to this population with noise (Sims, 2003) or without noise but irregularly (Mankiw & Reis, 2002).

Sims (2003) described a *rational inattention* theory, in which agents have an information-capacity constraint and pay little attention to macroeconomic information. To reduce the noise (measured by higher variance) in macroeconomic information, more capacity is reallocated to this field. As a result, the allocation in information capacity in other areas is limited, and agents will become less attentive. This lack of information brings along that prices will remain unchanged.

In the *sticky-information* model developed by Mankiw and Reis (2002), a few firms (the extensive margin) update the current situation and compute optimal prices given the updated information. The other firms are inattentive, as they continue to set prices based on outdated information. Reis (2006) showed that the producers rationally choose to be inattentive to new information (measured as a fixed cost) and calculated the optimal length of the producers'

"inattentiveness." During this period, prices will remain unchanged. In both the rational inattention and the sticky-information models, information is costly. The commodity markets in Curaçao are most likely transparent, as social contacts play a crucial role in the distribution of information. Firms cooperate, using their network, to distribute information. This occurs at low cost, which is not consistent with the sticky-information and rational inattention models. Hence, these theories are less likely to apply in Curaçao.

**Other Pricing Hypotheses**

A different angle in the analysis of price rigidity is offered in *fair pricing* models (Rotemberg, 2002, 2011). Their focus is on a consumer's (emotional) response to a firm's price setting. In these models, firms may stabilize prices out of an obligation of "fairness" to their consumers (Rotemberg, 2011). The benevolent attitude of firms toward their clientele is based on the belief that the "customer is always right." Price increases that are caused by cost increases are perceived as fair. In contrast, price increases resulting from a rise in demand are considered unfair. Consequently, firms do not always change the price following a demand shock, which may lead to price rigidity. This hypothesis may apply to Curaçao, as antagonized costumers in a close-knit community are bad publicity for these small firms.

In the hypothesis of *tacit collusion*, oligopolies "join forces" to achieve a joint maximization of profit by agreeing on the levels of price and/or output (Lipsey, Purvis, & Steiner, 1991). Even with temporary changes in demand, firms will be cautious to change prices, as they fear that the change in price can be misinterpreted and considered a competitive move (to increase their market share). The competitors' reaction can cause a price war, which will reduce the joint maximum profit. With the small market size of Curaçao, firms are likely to join forces and are more likely to apply tacit collusion.

The theory of the *fear of competitors' reaction* is also known as the *kinked demand curve* (Lipsey et al., 1991). This is based on assumptions about competitors' reaction. The oligopolist assumes that the competitor ignores price increases. Specifically, the competitor will not follow a price increase because this will result in a loss in the price-increasing firm's market share. Moreover, the oligopolist assumes that price reductions will be matched. This theory is likely to apply in the oligopolistic markets of Curaçao as it is more favorable for firms in a small community to cooperate and increase their joint profit maximation.

Appendix 1B: The Political Interference by Price Regulation and Regulatory Capture

Dexter, Levy, and Nault (2002) showed that *regulated prices* in the United States changed more slowly after a demand or a cost shock; moreover, the price change frequency of regulated commodities is lower than that of non-regulated ones. Price regulation was introduced in the 1960s in Curaçao, based on incomes and anti-inflationary policies (P. B. No. 117, 1961). The price regulation on selected commodities is implemented by applying a mark-up on the cost price (T. Magloire, personal communication, June 20, 2013). Regulated prices are changed at the arrival of goods, and therefore at random. For a few regulated commodities, prices are set to change periodically (De Minister van Financien, 2015). Regulated price changes are at random (time-dependent Calvo pricing) or periodical (time- dependent Taylor pricing). Time dependent pricing is a source for sticky prices.

*Regulatory capture* is the "process through which special interests affect state intervention in any of its forms" (Dal Bo, 2006, p. 203). In this dissertation, two forms of regulatory capture are described. In Peltzman's (1976) model, the government is the regulator. The aim of the government in this model is to maximize its power by balancing the benefits between the consumers (the voters) and producers (financial power to support the political parties). Regulatory capture occurs when the interest of one of these groups is not consistent with the policy set by the government as the regulator.

In Dal Bo's (2006) study, the government and the regulator were two separate entities. In this setting, the regulatory capture occurred when the regulators colluded with the producers. The consequences of this behavior was presented by Shapiro (2012), who described two recent calamities related to regulatory capture, namely the 2008 Wall Street collapse and the British Petroleum (BP) Deepwater Horizon oilrig. In both cases these industries used their large

influence to persuade the regulator. Subsequently, the regulator persuaded the policymakers to relax certain regulations. This has contributed to the financial crisis of 2008 and the environmental catastrophe of the oil spill in the Gulf of Mexico in 2010, respectively.

# CHAPTER 2

# THE CARIBBEAN MICRO-ISLANDS' COMMODITY MARKETS

Caribbean micro-islands are small, open, developing countries or territories. Their economies are suitably referred to as "tropical paradises" and "tax havens," reflecting their main export sectors of tourism (Shareef & Hoti, 2005) and international financial services (Hampton & Christensen, 2002). They are classified as small island developing states (SIDS). SIDS are "economically disadvantageous" and vulnerable due to their small size (Briguglio, 1995). One indicator that reflects the (economic) smallness of Caribbean micro-islands is the population size (Griffith, 2007). Caribbean micro-islands are inhabited by a few thousands of people, and thus they constitute small domestic commodity markets. Consequently, micro-islands are price takers in the world market, and their domestic prices are assumed to adjust frequently in accordance with the world market's prices.

Given these considerations, a case of sticky prices on the Caribbean micro-island of Curaçao may indicate that other factors than the world market's prices have an impact on its price setting. The central question is what these factors are. The objective of this chapter is to identify the factors or indicators that influence price setting in the commodity markets of the Caribbean micro-islands, particularly Curaçao. The analysis consists of two parts. The first part uses common characteristics of the SIDS, as described by Briguglio (1995), Armstrong and Read (2002), and Winters and Martins (2004), among others. The selected characteristics of SIDS are related to their commodity markets and price formation. From these characteristics, information on the price developments of the commodity markets are derived, particularly for Curaçao. The

second part of the analysis is island-specific, as it elaborates on the factors involved in price setting in the commodity markets in Curaçao.

Both analyses require considerable data mining in the databases of Caribbean micro-islands, as the data on micro-islands are scattered across several locations. Moreover, the databases on micro-islands exhibit series with missing observations, discontinued time series, or isolated random observations. In addition, the most recent data are rarely available. The lack of comparable data is the main challenge in data collection on micro-islands.

Despite these deficiencies, a dataset for the period of 1995–2006 was built for the comparative analysis of the Caribbean micro-islands. The collection of consistent data for the analysis on the selected common key indicators of the Caribbean micro-islands is an important contribution of this chapter.

The structure of this chapter is as follows. The first part of the analysis focuses on a sample of Caribbean micro-islands, which is defined in Section 2.1. Section 2.2 presents a literature overview of the constraints related to the small size and insularity of the commodities' markets on micro-islands, focusing on the limited room for domestic price setting. Section 2.3 presents a comparative analysis of the Caribbean micro-islands regarding selected common key indicators related to the commodity markets. This analysis presents preliminary information on the commodity markets of this group of islands, particularly Curaçao. Section 2.4, the second part of the analysis, uses sectoral data from Curaçao to study its commodity markets, and Section 2.5 presents conclusions on the price-setting behavior in Curaçao.

## 2.1. The Caribbean Micro-islands

For the classification of micro-islands, two basic concepts are important, namely the criteria for measurement of economic size and a threshold value for economic smallness. Since

the studies performed by Demas (1965) and Khalaf (1974), three criteria are routinely used to measure economic smallness, namely population size, land area, and production; these criteria may also be used in combination (Crowards, 2002). The production is measured by the gross domestic product (GDP) per capita or by the aggregate value of the GDP or by the gross national product (GNP). Although the population size is the most commonly used criterion, the choice of the most fitting indicator of smallness has to be associated with the subject of research, which in this case is the domestic goods and services markets of Caribbean micro-islands.

For the commodity markets on micro-islands, the potential sales depend on the demand of the consumers, which are primarily domestic consumers. The examples of the Bahamas, a country with fairly large land area and small commodity markets, and Bermuda, with a high gross domestic product (GDP) per capita and small commodity markets, may show to illustrate that land area and production are less appropriate than population to define the domestic commodity market size. The demand of domestic commodities mainly depends on the size of the population, the price, the price of substitutes, and the GDP per capita. The example of Bermuda shows that the GDP per capita is not an adequate measure for small Caribbean commodity markets. Hence, the population size is the most suitable criterion for these markets.

Related to the choice of the criterion of economic smallness is its threshold value. As size is a relative concept, the classification of small economies in the economic literature is arbitrary, and practitioners are divided concerning the threshold value of (economic) smallness. In the literature, the most commonly used thresholds are 1 and 1.5 million inhabitants. The common practice for defining smallness in the Commonwealth of Nations and the United Nations (UN) is a threshold value of 1 million inhabitants (Sutton & Payne, 1993). Sutton and Payne (1993) and Anckar (1999) also used the threshold value of 1 million people to categorize

small countries. The Commonwealth Secretariat (The Round Table, 2011) adapted the upper limit to 1.5 million. In this dissertation, the focus is on the smallest of the world's islands; hence, the lowest threshold value of 1 million inhabitants applies.

SIDS were recognized in 1992 by the UN, defined as "low-lying coastal countries that share similar sustainable development challenges, including population, limited resources, susceptibility to natural disasters, vulnerability to external shocks, and extensive dependence on international trade" (the United Nations Environment Program [UNEP], n.d.). This broad definition of SIDS reaches beyond islands to include small coastal economies, although the "I" in the acronym SIDS stands for "island." As a consequence of this inconsistency, non-island economies, such as Belize, Suriname, and Guyana, are awkwardly classified as SIDS, and are listed on the official UN list of SIDS (Fialho & van Bergeijk, 2016, p. 20). SIDS are categorized into three geographical areas, as follows: the Caribbean; the Pacific; and the combined area of Africa, Indian Ocean, Mediterranean, and South China Sea (AIMS).

To draw the list of Caribbean micro-islands, the official UN list of SIDS is used as a starting point. The non-island economies (Belize, Suriname, and Guyana) and the Caribbean islands consisting of more than 1 million inhabitants (Dominican Republic, Haiti, Jamaica, Puerto Rico, Trinidad, and Cuba[4]) are excluded from the category of micro-islands. Added to the official list of the UN SIDS are the islands of Bermuda, Guadeloupe, Martinique, Saint Barthelemy, Tobago, the Turks and Caicos Islands, and the countries listed under the former collective name of the Netherlands Antilles. After Aruba abandoned the Netherlands Antillean confederation in 1986, the Netherlands Antilles consisted of Curaçao, Sint Maarten, Bonaire, Sint Eustatius, and Saba. In 2010, Curaçao and Sint Maarten became autonomous countries

[4] Cuba was not an open economy until 2015. Cuba–US trade started at the beginning of 2015.

within the Kingdom of the Netherlands, and the islands of Bonaire, Saba, and Sint Eustatius (the BSS or BES islands) became Caribbean municipalities of the Kingdom of the Netherlands.

Table 2.1 shows the list of the Caribbean micro-islands, ranked by population size in the year 2006. This list shows 24 countries and territories, where several consist of groups of islands, for example, the Bahamas, the British and US Virgin Islands, and the BSS islands. For completeness, Tobago is listed as a Caribbean micro-island. However, this island forms one country with the larger Trinidad, and the available data on Tobago are usually combined with the data on Trinidad. Hence, its inclusion in the analysis would bring inconsistency into the data on the micro-islands; Tobago is therefore excluded from further consideration. The BSS islands are also excluded from further analysis due to a lack of data resulting from their recent change in status to Caribbean municipalities of the Kingdom of the Netherlands.

To summarize, the Caribbean micro-islands are defined as Caribbean SIDS with a population size less than 1 million. In fact, each of the Caribbean micro-islands has a population of less than half a million.

Table 2.1

*The Population of the Caribbean Micro-Islands in 2006 (in Number of inhabitants)*

| Country | Population 2006 |
|---|---|
| Montserrat | 5,789 |
| Saint Barthélemy (Saint Barths) (2009)[a/b] | 8,902 |
| Anguilla | 12,445 |
| BSS islands[a/c] | 15,851 |
| Virgin Islands, British (2001) [d] | 23,161 |
| Turks & Caicos[a/e] | 33,202 |
| Saint Martin (2009)[a/b] | 35,263 |
| Sint Maarten[a/c] | 37,629 |
| Saint Kitts & Nevis | 49,774 |
| Cayman Islands[f] | 53,172 |
| Tobago (2000)[g] | 54,084 |
| Bermuda[a] | 63,800 |
| Dominica | 67,621 |
| Antigua & Barbuda | 84,097 |
| Aruba[c] | 103,772 |
| Grenada | 105,597 |
| Virgin Islands, US[h] | 113,689 |
| Saint Vincent & Grenadines | 119,772 |
| Curaçao[a/c] | 139,596 |
| Saint Lucia | 163,071 |
| Barbados | 292,930 |
| Bahamas | 327,279 |
| Martinique (2009)[a/b] | 398,000 |
| Guadeloupe (2009)[a/b] | 447,000 |
| *Average* | 114,812 |

Table 2.1

*The Population of the Caribbean Micro-Islands in 2006 (in Number of inhabitants)*

*Notes*.

[a.] This country has been added to the UN list of SIDS.

[b.] Data on Saint Barths, Saint Martin, Martinique, and Guadeloupe are from Census 2009 of "Institut national de la statistique et des études économiques," (INSEE), the National Institute of Statistics and Economic Studies of France. Saint Martin (French territory) and Sint Maarten (Dutch territory) are two "countries" on one island.

[c.] The BSS (Bonaire, Saba, Sint Eustatius) islands made up the former Netherlands Antilles, together with Curaçao, Aruba, and Sint Maarten. The data on Bonaire and Curaçao are from the statistical office of the former Netherlands Antilles, and the data on Sint Maarten, Sint Eustatius, and Saba are the author's estimates.

[d.] The British Virgin Islands include, Tortola, Virgin Gorda, Jost van Dyke, and Agagada. The data are from the Census Report 2001 of the British Virgin Islands.

[e.] Department of Economic Planning and Statistics of Turks and Caicos (n.d.)

[f.] The Cayman Islands consist of Grand Cayman, Cayman Brac, and Little Cayman. The data are from the "Statistical Compendium 2008" of the Economics and Statistics Office of the Cayman Islands.

[g.] With Trinidad, Tobago forms a twin island country. The data are from the Central Statistical Office Trinidad and Tobago, Census 2000.

[h.] The 2006 data are retrieved from "Annual Economic Indicators" of the Bureau of Economic Research of the US Virgin Islands (n.d.)

Source: Adapted list from the United Nations [UN] (n.d.)

## 2.2. Micro-Islands' Commodities Markets

SIDS differ from other developing nations in that they "face a greater risk of marginalization from global activities than other developing countries" (Santos-Paulino, 2010, p. 855). Their *small* sizes are "economically disadvantageous" (Briguglio, 1995, p. 1616), and introduce in an "overall feasibility constraint" (Winters & Martins, 2004, p. 376). Micro-islands have two main common characteristics, namely their insularity and small size.

*Insularity* refers to being surrounded by sea and entails dependency on air and sea transportation. It is often confused with remoteness, suggesting inaccessibility. One way to

measure the accessibility of micro-islands is through the frequency of the connections by air and sea transportation for travel and the delivery of goods. As most Caribbean micro-islands are tourist destinations, they have frequent air transportation from and to American and European markets. In addition, the goods markets on the Caribbean micro-islands are regularly supplied by imports from the international markets. Caribbean *inter-islands'* accessibility, in contrast, is limited due to lack of interregional transportation. This is associated with small trade volumes and low numbers of regular travelers. The low volume of trade, and hence the lack of freight among micro-islands, is probably partly due to the lack of comparative advantage between countries with similar export sectors.

The second characteristic, namely small size, has several implications for the commodity markets. First, the smallness results in small, fragmented freights (Briguglio, 1995) at high transportation costs. Micro-islands have approximately 70% higher sea freight transportation costs, 57% higher average personal air travel costs, and 4.1% higher average airfreight costs than larger economies (Winters, 2005). In particular the Caribbean area, the relatively high sea freight cost compared to airfreight cost is explained by the collusive behavior in the international sea transportation sector. (J. Gois, personal communication, May 27, 2015).

Beside the high transportation costs, an implication of the small size is the uncompetitive production levels in the goods markets of micro-islands. The production on micro-islands is constrained by the small domestic goods markets; thus, these economies have small domestic production units. Armstrong and Read (2002) used the concept of "economic sub-optimality" (p. 436). The demand of the domestic goods market is too small (lack of scale), while an "optimal" output level to produce efficiently is too large. The second implication of the small size is

therefore that Caribbean micro-islands lack economies of scale and produce at uncompetitive levels.

From an opposing perspective, Griffith (2007, p. 956) argued that a globally competitive level of production on the Caribbean islands can be reached by "creating knowledge skills." Moreover, globalization also implies adding foreign demand to the small markets of islands and diversifying the economic structure. From this viewpoint, both *economies of scale* and *scope* can be reached on small islands. However, to the best of my knowledge, only the micro-islands of Bermuda and the Bahamas have been able to achieve economies of scale in the international financial *services* markets, while economies of scale in the *goods* markets are not feasible on any of the Caribbean micro-islands. The reason for this is that the production cost per unit and the transportation costs in the good markets are relatively higher than they are in a larger country (Winters & Martins, 2004).

The high costs of transportation and production may function as a natural barrier for a new firm to enter the market, which limits the number of firms. Market structures with limited number of firms are called *monopolies* or *oligopolies*. The third implication of smallness is that there is a "tendency toward" market structures of *monopolies* or *oligopolies* on small islands (Briguglio, 1995, p. 1617).

The fourth implication of smallness is that the commodity markets have a narrow economic structure, and the economies are not diversified and lack economies of scope. For Caribbean micro-islands, economies of scope are absent, and a limited variety of goods are produced. These islands have restricted exports of goods and high imports of goods, which illustrate their narrow production structures. According to Medina Cas and Ota (2008), "while small states tend to *produce* a narrow range of goods and services, they *use* a wide variety" (p.

15). As a consequence, their high imports have to be financed by exports, in this case by high export of services. The fifth implication of smallness is the high degree of openness and lack of economies of scope among micro-islands.

Sixth, as result of their smallness and openness, micro-islands adopt *fixed–exchange rate regimes* (Caramazza & Aziz, 1998, p. 6). A pegged exchange rate is advantageous, as it makes trade in commodities easier and more cost efficient (Abel & Bernanke, 2005). In addition, inflation may be lower in a fixed–exchange rate regime (Abel & Bernanke, 2005). Flexible exchange rates are disadvantageous, as they have a negative impact on growth in less financially developed countries (Aghion, Bachetta, Ranciere, & Rogoff, 2009). The small financial markets of Caribbean micro-islands are not particularly well developed; hence, adopting flexible exchange rates may have a negative impact on the growth rates of these islands. The disadvantage of fixed exchange rates, however, is that their pegged currencies are sometimes overvalued, thereby undermining their competitiveness.

In conclusion, (Caribbean) micro-islands have small, fragmented freight due to their smallness. Their insularity means dependency on air and sea transportation. The collusive price setting in sea transportation combined with the small trade volumes of Caribbean micro-islands may partly explain the typically high cost of transportation. The smallness of Caribbean micro-islands also leads to openness, fixed-exchange rates, and lack of economies of scale and scope. Their production structures are narrow and most firms are monopolies or oligopolies.

## 2.3. The Impact of Selected Indicators on the Commodity Markets

The common indicators, which are characteristics of Caribbean micro-islands, are selected based on their effect on the commodity markets. The characteristics that are used as indicators may provide information about some aspects of the commodity markets. These indicators are the colonial history, monetary dependency (dependency on the monetary policy of another country, either by choice or by necessity), low inflation rates, a small and migratory population, a small land area, high volatility in the GDP per capita growth rates, and openness. The effect of these characteristics on the commodity markets is analyzed in this section.

### 2.3.1. The Colonial History

Table 2.2 provides an overview of the Caribbean micro-islands by current constitutional status. The second column in the table shows that most micro-islands have constitutional ties with a larger economy. Anguilla, Bermuda, Cayman Islands, Montserrat, Turks and Caicos, and the (British) Virgin Islands are dependencies of England. Guadeloupe and its dependencies (Saint Barths and Saint Martin) and Martinique are “Départements d’outre-mer,” or French Overseas Departments and Territories. The former Netherlands Antilles—Aruba, Bonaire, Curaçao, Saba, Sint Eustatius, and Sint Maarten—have constitutional ties with the Netherlands, and the US Virgin Islands are part of the United States. With the exception of the US Virgin Islands, the constitutional ties indicate the bond between the Caribbean micro-islands and their respective mother countries. Hence, for most islands, their constitutional status is rooted in the colonial past.

The colonial past affects the commodity markets of the Caribbean micro-islands through their population sizes and import preferences. Most of the former colonies have high imports from their mother countries. The preference for Dutch cheese instead of regional cheese and the

demand for commodities from the Netherlands in Curaçao, for example, originated in the colonial period. As a consequence, the commodities in Curaçao to a significant extent consist of goods produced in the Netherlands. In addition, migration to and from the islands has influenced the sizes of the domestic commodity markets.

Most of the countries without constitutional ties (third column in Table 2.2) participate in two important entities of (economic) cooperation, namely the Organization of the Eastern Caribbean States[5] (OECS) and the Caribbean Community and Common Market (CARICOM).[6] The OECS currently consists of 10 micro-islands and provides for a common commodity market that primarily includes the Eastern Caribbean countries. The members of the OECS consist of the six independent micro-islands and Montserrat, the only micro-island with constitutional ties. The associate members of the OECS are the micro-islands of Anguilla, the British Virgin Islands, and Martinique, all of which have constitutional ties. A larger internal market is provided by CARICOM, including both micro- (14) and larger (5) Caribbean islands. Unfortunately, due to the lack of inter-island accessibility (sea and air transportation) and the lack of comparative advantage, the benefits of the larger internal markets will be limited.

[5] The OECS is an intergovernmental organization with the aim to achieve economic harmonization and integration. Members are: Antigua and Barbuda, Dominica, Grenada, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, and Montserrat. Associate members are Anguilla, British Virgin Islands, and Martinique.

[6] CARICOM is an organization aiming at economic integration with a single market (of goods) on the Caribbean area. To date CARICOM consists of Antigua and Barbuda, the Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Lucia, Saint Kitts and Nevis, Saint Vincent and the Grenadines, Suriname, and Trinidad and Tobago. The associate members are: Anguilla, Bermuda, British Virgin Islands, Cayman Islands, and Turks and Caicos.

Table 2.2

*Caribbean Micro-Islands by Constitutional Status in 2012*

| Country | Constitutional ties | No constitutional ties |
|---|---|---|
| Anguilla | British Overseas Territory | |
| Antigua & Barbuda[a/b] | | Independent state |
| Aruba | Part of the Kingdom of the Netherlands | |
| Bahamas[b] | | Independent state |
| Barbados[b] | | Independent state |
| Bermuda | British Overseas Territory | |
| Cayman Islands | British Overseas Territory | |
| Curaçao | Part of the Kingdom of the Netherlands | |
| Dominica[a/b] | | Independent state |
| Grenada[a/b] | | Independent state |
| Guadeloupe | French Overseas Departments and Territories | |
| Martinique[a] | French Overseas Departments and Territories | |
| Montserrat[a/b] | British Overseas Territory | |
| Saint Barthélemy | French Overseas Departments and Territories | |
| Saint Martin | French Overseas Departments and Territories | |
| Saint Kitts & Nevis[a/b] | | Independent state |
| Saint Lucia[a/b] | | Independent state |
| Saint Vincent & Grenadines[a/b] | | Independent state |
| Sint Maarten | Part of the Kingdom of the Netherlands | |
| Turks and Caicos Islands | British Overseas Territory | |
| Virgin Islands (British) | British Overseas Territory | |
| Virgin Islands (US) | Territory of the United States | |

*Note*.

[a.] Member of the Organization of Eastern Caribbean States (OECS). Anguilla, the British Virgin Islands, and Martinique are associate members.

[b.] Member of the Caribbean Community and Common Market (CARICOM). Anguilla, Bermuda, British Virgin Islands, Cayman Islands, and Turks and Caicos are associate members.

Source: Websites of the micro-islands.

In short, the colonial history has influenced the size and composition of the commodity markets. For countries with constitutional ties, in principle, the migration of the islanders to and from the mother country is unrestricted. Therefore, the migration flows from the micro-island to the mother country reduce the size of the domestic commodity markets for the Caribbean micro-islands. For the countries without constitutional ties in particular, their membership with the OECS, CARICOM, or both extends their small commodity markets. The benefits of these larger internal markets, however, are restricted due to lack of transportation and lack of comparative advantage.

### 2.3.2. Monetary Dependency

Caribbean micro-islands have monetary dependency, as they do not have their own monetary policy, and their monetary policy is tied to another country, as shown in Table 2.3. Two forms of monetary dependency are the fixed-exchange rate and dollarization. Dollarization is when a country uses a foreign currency that substitutes for the domestic currency (Berg & Borensztein, 2000). Although in the case of the Caribbean micro-islands, the foreign currency used to substitute for the domestic currency is usually the US dollar, the terminology of dollarization is broadly applied for the foreign currency of choice; thus, it also covers the use of the euro or the British pound.

Since the official introduction of the fixed exchange rates or dollarization in these micro-islands, their monetary regimes have remained unchanged; thus, the official peg is equal to the actual peg. Most of the Caribbean micro-islands have a long-lasting peg with the US dollar or are dollarized, with the longest period of dollarization evident in the British Virgin Islands, where it started in 1959. Turks and Caicos and the British and US Virgin Islands use the US dollar as legal tender. The choice for the peg, or the use of the US dollar in most of the

Caribbean micro-islands, is based on the fact that the United States is their main trading partner. Of the Caribbean micro-islands, only the French “Départements d’outre-mer” use the euro as their legal tender. Consistent with most other Caribbean islands, Curaçao has a long-lasting peg with the US dollar. This is particularly important for commodity markets in Curaçao, as the United States represents its main market for trade, and most of its commodities are traded in US dollars. Consequently, the exchange rate risk for Curaçao is limited to the smaller share of its non–US currency trade. In conclusion, the peg of the exchange rate of Curaçao to the US dollar has remained unchanged for years, and it is not likely that this constant factor has influenced the price formation of the denominated trade of Curaçao in in US dollars.

Table 2.3

*Caribbean Micro-Islands by Monetary Dependency as per April 30, 2012*
*(Domestic Currency for 1 US $ or Dollarized)*

| Country | Pegged to 1 US $ | Dollarized ($ or €) | Year peg/ dollarization | Monetary union |
|---|---|---|---|---|
| Anguilla | 2.70 XCD[a] | | 1976 | ECCU[b] |
| Antigua & Barbuda | 2.70 XCD | | 1976 | ECCU |
| Aruba | 1.77 AWG[c] | | 1986 | |
| Bahamas | 1.00 BSD[d] | | 1966 | |
| Barbados | 2.00 BBD[e] | | 1975 | |
| Bermuda | 1.00 BMD[f] | | 1970 | |
| Cayman Islands | 1.23 KYD[g] | | 1974 | |
| Curaçao | 1.79 ANG[h] | | 1971 | |
| Dominica | 2.70 XCD | | 1976 | ECCU |
| Grenada | 2.70 XCD | | 1976 | ECCU |
| Guadeloupe | | € | 2002 | |
| Martinique | | € | 2002 | |
| Montserrat | 2.70 XCD | | 1976 | ECCU |
| Saint Barthélemy (Saint Barths) | | € | 2002 | |
| Saint Kitts & Nevis | 2.70 XCD | | 1976 | ECCU |
| Saint Lucia | 2.70 XCD | | 1976 | ECCU |
| Saint Vincent & Grenadines | 2.70 XCD | | 1976 | ECCU |
| Sint Maarten | 1.79 ANG[h] | | 1971 | |
| Turks and Caicos Islands | | US $ | 1973 | |
| Virgin Islands (British) | | US $ | 1959 | |
| Virgin Islands (US) | | US $ | n.a. | |

*Notes*. [a] XCD: Eastern Caribbean dollar, [b] ECCU: Eastern Caribbean Monetary Union, [c] AWG: Aruban guilder, [d] BSD: Bahamian dollar, [e] BBD: Barbadian dollar, [f] BMD: Bermudian dollar, [g] KYD: Cayman Islands dollar, [h] ANG: after the dissolution of the Netherlands Antilles on October 10, 2010, the islands of Curaçao and Sint Maarten continued with the Netherlands Antillean guilder (ANG).
Source: Websites of the islands.

### 2.3.3. Inflation Rates

Inflation rates consist of imported inflation, transportation cost changes, and the factors of domestic inflation (e.g., wage cost change). The imported inflation is influenced by exchange rate changes. Imports to Caribbean micro-islands consist of imports from their (former) mother countries and/or main trading partner(s). For the Caribbean islands—with the exception of the French territories—a large share of their imports are denominated in US dollars. The Caribbean micro-islands' annual inflation rates and volatility in the commodity markets in the period of 1995−2006 are shown in the second and third columns of Table 2.4. The inflation rates of the former mother countries and their major trading partner are used as indicators of the import prices for the Caribbean micro-islands. This period was marked by the introduction of the euro and low inflation rates. In the period before the introduction of the euro in 1999, the mother countries of France and the Netherlands had their own currencies, namely the French franc and the Dutch guilder. The average (M) and the standard deviation (SD) of the inflation rates in the period of 1995–2006 were as follows: France M=1.6%, SD=0.5%; the Netherlands M=2.2%, SD=0.8%; and the UK M=1.7%, SD=0.6%. The major trading partner of the micro-islands in the Caribbean is the United States, and its average and standard deviation inflation rate were M=2.6% and SD=0.6%, respectively.

The inflation variation of the Caribbean micro-islands is large considering the small variations in inflation of their main trading partners. Similar to most other Caribbean micro-islands, the variability in inflation was higher in Curaçao in the study period compared to that of its main trading partners. Inflation (and the variation in inflation) on the Caribbean micro-island may have been affected by the exchange rate volatility with the non–US dollar trading partners, transportation cost changes, or domestic factors of inflation (wage or capital cost changes).

Table 2.4

*The Inflation Rates on the Caribbean Micro-Islands (in Percent, 1995–2006)*

| Country | The average inflation (M) 1995−2006 | Standard deviation (SD) 1995−2006 |
|---|---|---|
| Dominica | 1.5 | 0.7 |
| Bahamas | 1.7 | 0.7 |
| Guadeloupe[a] | 1.7 | 1.1 |
| Saint Vincent & Grenadines | 1.8 | 1.4 |
| Martinique[a] | 1.8 | 0.7 |
| Grenada | 1.9 | 0.9 |
| Curaçao[b] | 2.4 | 1.6 |
| Cayman Islands[c] | 2.4 | 1.6 |
| Saint Lucia | 2.6 | 1.9 |
| Barbados | 2.8 | 2.8 |
| Aruba | 3.1 | 0.6 |
| Anguilla | 3.4 | 2.4 |
| Saint Kitts & Nevis | 3.6 | 2.4 |
| Antigua & Barbuda | n.a. | n.a. |
| Bermuda | n.a. | n.a. |
| Montserrat | n.a. | n.a. |
| Saint Barthélemy (Saint Barths) | n.a. | n.a. |
| Turks and Caicos | n.a. | n.a. |
| Virgin Islands, British | n.a. | n.a. |
| Virgin Islands, US | n.a. | n.a. |
| *Average* | 2.4 | 1.4 |

*Notes.*

[a.] INSEE for 1999–2006.

[b.] The Central Bureau Statistics of Curaçao (CBS). (CBS, n.d.)

[c.] Economic and Planning Office of the Cayman Islands.

Sources: Data from the other islands were collected from the International Financial Statistics.

### 2.3.4. Openness

In Table 2.5, the import-to-GDP, export-to-GDP, and the trade ratios (export and imports as share of the GDP), are shown.[7] A high trade ratio implies high degree of openness. As shown in Table 2.5, Caribbean micro-islands have a high degree of openness. The import ratios show

that for most of the Caribbean micro-islands, more than 60% of commodities are imported, capturing their dependency on the international markets for their domestic commodity markets. Similarly, the import-to-GDP ratio of 74% in Curaçao emphasizes that the commodity markets are mostly supplied by imported goods. It may be expected that the prices in the domestic commodity markets will adjust in line with the import prices.

Table 2.5

*The Import and Export Ratios of the Caribbean Micro-Islands in 2010 (as Ratio of the GDP)*

| Country | Import/GDP 2010 | Export/GDP 2010 | (Export and Import)/GDP 2010 |
|---|---|---|---|
| Grenada (2011) | 0.49 | 0.21 | 0.70 |
| Saint Vincent & Grenadines (2011)[a] | 0.56 | 0.27 | 0.83 |
| Saint Kitts & Nevis | 0.53 | 0.21 | 0.84 |
| Bahamas[a] | 0.50 | 0.41 | 0.91 |
| Dominica (2011)[a] | 0.54 | 0.39 | 0.95 |
| Bermuda[a] | 0.55 | 0.41 | 0.96 |
| Monserrat | 0.74 | 0.21 | 0.96 |
| Barbados | 0.51 | 0.46 | 0.97 |
| Antigua and Barbuda (2011)[a] | 0.59 | 0.45 | 1.04 |
| Saint Lucia | 0.62 | 0.51 | 1.13 |
| Anguilla | 0.72 | 0.45 | 1.17 |
| Cayman Islands[a] | 0.61 | 0.62 | 1.23 |
| Aruba | 0.76 | 0.61 | 1.37 |
| Curaçao (2011)[b] | 0.74 | 0.67 | 1.41 |
| Turks & Caicos Islands | 0.80 | 0.62 | 1.42 |
| Virgin Islands (British) | 0.77 | 1.11 | 1.88 |
| Guadeloupe | n.a. | n.a. | n.a. |
| Martinique | n.a. | n.a. | n.a. |
| Saint Barthélemy (Saint Barths) | n.a. | n.a. | n.a. |
| Virgin Islands (US) | n.a. | n.a. | n.a. |
| *Average* | 0.64 | 0.51 | 1.16 |

*Notes.*

[a.]The Word Bank data in parentheses represent the reported year when this is not 2010.

[b]The Central Bank of Curaçao and Sint Maarten.

Source: UN (2012).

### 2.3.5. Development in Population Sizes

Table 2.6[8] shows the development in population sizes of the Caribbean micro-islands. The development in the average population sizes is important, as it gives an indication of the development of the commodity markets' sizes. The second column in the table shows the average population size in 1960−2006. The largest micro-economy of this region is the island of Guadeloupe, consisting of approximately 450,000 inhabitants; the smallest is Anguilla, with a population of approximately 8,000. The SDs in the third column show the variation in the population sizes, which may be related to migration. It is worth mentioning that there has been extensive emigration from Montserrat caused by the eruptions of the Soufrière Hills volcano, which has been active since 1995. As a consequence of this adverse supply shock, a negative population growth rate (–1.4% in Column 4) and a high volatility in population growth rate of 4.8% (Column 5) were registered.

Low population growth rates and high volatility have been reported. Similar to the other Caribbean micro-islands, the developments in the population data in Curaçao showed low population growth caused by migration (The Central Bank of Curaçao and Sint Maarten [CBCS], 2001). The sizes of the Caribbean micro-islands' commodity markets have consequently shown slow growth.

[8] The data are from the International Financial Statistics (IFS) of the International Monetary Fund (IMF), the National Institute of Statistics and Economic Studies of France, the INSEE, the Social Science Research Council (SSCR), the World Bank, and the Central Bureau of Statistics of Curaçao (CBS).

Table 2.6

*The Caribbean Micro-islands by Population Size 1960–2007*

| Country | Average population size (1960–2007) | SD of average population size | Average growth rate for 1960–2007 (in %) | SD of average growth rate for 1960–2007 (in %) |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| Anguilla[a] | 8,388 | 2,101 | 1.7 | 1.1 |
| Turks & Caicos[c] | 8,611 | 3,345 | 2.8 | 2.3 |
| Montserrat[a] | 10,121 | 2,484 | -1.4 | 4.8 |
| Virgin Islands, British[c] | 12,371 | 2,101 | 2.5 | 1.7 |
| Cayman Islands[d] | 31,902 | 8,604 | 4.2 | 0.7 |
| Saint Kitts & Nevis[a] | 45,159 | 3,103 | 0.0 | 1.9 |
| Bermuda[e] | 56,371 | 5,238 | 0.8 | 0.9 |
| Dominica[a] | 67,478 | 3,894 | 0.3 | 0.8 |
| Aruba[a] | 69,274 | 15,930 | 1.6 | 1.7 |
| Antigua & Barbuda[a] | 69,801 | 7,325 | 0.9 | 1.7 |
| Virgin Islands, US[f] | 86,669 | 25,813 | 3.3 | 3.8 |
| Grenada[a] | 96,294 | 4,369 | 0.4 | 1.0 |
| Saint Vincent & Grenadines[a] | 102,436 | 11,809 | 0.8 | 0.3 |
| Saint Lucia[a] | 125,793 | 22,443 | 1.3 | 0.3 |
| Curaçao[g] | 142,386 | 8,081 | 0.3 | 1.7 |
| Bahamas[a] | 226,388 | 63,357 | 2.4 | 1.2 |
| Barbados[a] | 260,100 | 20,635 | 0.5 | 0.2 |
| Martinique[h] | 344,625 | 30,625 | 0.7 | 0.3 |
| Guadeloupe[i] | 359,563 | 50,633 | 1.2 | 0.5 |
| Saint Barthélemy (Saint Barths) [b] | n.a. | n.a. | n.a. | n.a. |
| *Average* | 111,775 | 15,363 | 1.3 | 1.4 |

*Notes.*

[a.] International Financial Statistics.

[b.] INSEE Census 2009, included in Guadeloupe.

[c.] SSRC (1960–1998).

[d.] Cayman Islands consist of Grand Cayman, Cayman Brac, and Little Cayman. The data (1979–2007) are from the Statistical Compendium (2005, 2008) of the Economics and Statistics Office.

[e.] World Bank data from 1960–2006.

[f.] The US Virgin Islands consist of St. Croix, St. John, and St. Thomas.

[g.] Curaçao data are from the CBS of Curaçao.

[h.] INSEE.

INSEE: the data include Saint Barthélemy and Saint Martin (French Sint Maarten)

### 2.3.6. Land Area

Table 2.7 lists the data of the land area (in square kilometers). The data show the smallness of the countries' areas; Saint Barths is the smallest, at 22 $km^2$, while the largest is the Bahamas, an archipelago comprising 700 islands, with a land area of approximately 14,000 $km^2$. The land sizes in the Caribbean area are small, which may indicate a scarcity of land. This is likely to drive up property prices. The three Caribbean micro-islands with the highest property prices[9] are Bermuda ($7,056), British Virgin Islands ($6,469), and Barbados ($4,189). The property price ($2,162)[10] in Curaçao (and Bonaire) is considered moderate compared with the aforementioned three Caribbean micro-islands.

The demand for land on the Caribbean micro-islands probably pushed the property prices upward. High property prices were likely passed on in the cost of production, and consequently reflected in the overall prices in the Caribbean commodity markets. However, due to lack of time series data, the impact of property prices on price setting must be addressed in further research.

[9] Price of property per square meter ($m^2$) based on apartments of 120 $m^2$ in the center of the city in 2013 (Global Property Guide, 2015). In Brazil, the property price per square meter was $3,751 in 2015, and in the Netherlands, the price was €4,907 per square meter in 2015 (approximately $5,404; (Global Property Guide, 2015). All prices based on apartments of 120 $m^2$.

[10] Only the combined property prices of Curaçao and Bonaire were reported for 2008 (Global Property Guide, 2015).

Table 2.7

*The Size of the Land Area of the Caribbean Micro-Islands ($km^2$)*

| Country | Land area ($km^2$) |
|---|---|
| Saint Barthélemy (Saint Barths) | 22 |
| Bermuda | 53 |
| Anguilla | 96 |
| Montserrat | 104 |
| Virgin Islands, British[a] | 174 |
| Aruba | 193 |
| Cayman Islands[a] | 259 |
| Saint Kitts & Nevis[a] | 261 |
| Grenada | 344 |
| Virgin Islands, US[a] | 349 |
| Saint Vincent & Grenadines[a] | 389 |
| Barbados | 431 |
| Antigua and Barbuda[a] | 440 |
| Curaçao[a] | 444 |
| Saint Lucia | 616 |
| Dominica | 751 |
| Turks and Caicos[a] | 948 |
| Martinique | 1,077 |
| Guadeloupe | 1,779 |
| Bahamas[a] | 13,935 |
| *Average* | 1,133 |

*Note*.
[a.]This country is an archipelago
Source: World Bank.

### 2.3.7. The Level of and Development in GDP Per Capita

An indicator for the real production per capita[11] is the GDP per capita in *constant prices*. However, GDP data in constant prices (or in real terms) are lacking, as most Caribbean micro-islands do not have GDP deflators. The growth rate of the GDP (per capita) in constant prices is proxied by subtracting the inflation rate from the growth rate of the nominal GDP (per capita).

[11] The GDP per capita in real terms is also a proxy of the productivity of labor, assuming that the other factors of production are constant and no technological progress has occurred.

The wedge between the nominal GDP (per capita) and the GDP (per capita) in constant prices is small, as Caribbean micro-islands have low inflation rates (Table 2.4). For an approximation of production per capita therefore, the nominal GDP per capita is appropriate.

In Table 2.8, the GDP per capita data in nominal US dollars[12] in the period of 1995−2006 are presented.[13] The second column of Table 2.8 shows the large differences in the averages of GDP per capita across the micro-islands in the period of 1995−2006. Bermuda has a high mean GDP per capita of $57,660, contrasting to Grenada, which exhibits a small GDP per capita of $2,909 on average. Column 4 of Table 2.8 reports high average per capita nominal growth for most Caribbean micro-islands in the period of 1995−2006. The low inflation rates reported in Table 2.4 and the high nominal growth rates per capita are an indication of s*ustainable*[14] growth rates. In the fifth column of Table 2.8, high standard deviations of nominal GDP per capita growth rates in some of the micro-islands are reported. The volatility in growth rates is mainly due to natural disasters in the Caribbean area, including the hurricanes hitting Anguilla (Luis in 1995), Grenada (Ivan in 2004), and the Bahamas (Wilma in 2005) and the eruptions of the Soufrière Hills volcano in Montserrat since 1995.

The sixth column shows the per capita GDP of a single observation, which is for the year 2004. Point estimates for 2004 were not always available; hence, the year of the reported

[12] The data of the French Overseas Departments and Territories that were originally reported in euros were converted into US dollars by applying the average exchange rate of 2006. In the second column, the average per capita GDPs in the period of 1995–2007 are shown. The population statistics for Guadeloupe includes the inhabitants of Saint Barthelemy and Saint Martin. The data on the GDP of Guadeloupe include only the production of Guadeloupe. Hence, the data of the average GDP per capita of Guadeloupe is an underestimated value of the GDP of this country.

[13] Tables 2.6 on population and 2.8 on the GDP per capita use different time periods, and the choice of period is based on the data availability. The population size data are for 1960–2007, while the GDP per capita data are for 1995–2006. The discrepancy between the two periods is due to the lack of data on the GDP in the period before 1995. The data on the "Départments et territories d'outre-mer" are unavailable in the world databases and only accessible in the INSEE.

[14] A sustainable growth rate is defined as GDP (per capita) growth in real terms of 2% and higher.

observation is listed in parentheses. These point estimates fill the information gap on production in the countries of Turks and Caicos and the British and US Virgin Islands. These data show relatively high GDP per capita; however, from a single observation, no additional information on the developments in their production per capita could be derived.

Similar to other Caribbean micro-islands, Curaçao has a relatively high per capita GDP, indicating a relatively sizeable production per capita. In contrast to most other Caribbean islands, the GDP per capita growth rates in Curaçao were low, implying underperformance in Curaçao.

To summarize, most Caribbean countries reported high growth rates; the exceptions were Montserrat and Curaçao. The small growth rates in Montserrat are the result of an adverse supply (environment-related) shock. The underperformance in Curaçao is discussed in the second part of the analysis. As only data on the market structure of Curaçao were available, the second part of the analysis discusses the behavior of price setters and its implications for the case of Curaçao.

Table 2.8

*The Caribbean Micro-Islands by Average GDP Per Capita, 1995–2006*

| Country | Average per capita nominal GDP (1995–2006) (US $) | SD of the average per capita nominal GDP (US $) | Average growth rate of nominal GDP per capita (in %) | SD of the growth rate of per capita nominal GDP (in %) | Per capita nominal GDP in 2004 (US $) |
|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) |
| | Countries pegged to the US $/with US $ | | | | |
| Grenada | 2,909 | 559 | 6.3 | 10.5 | 2,891 |
| St. Vincent & Grenadines | 3,050 | 536 | 5.4 | 2.9 | 3,495 |
| Dominica | 3,887 | 406 | 3.6 | 3.8 | 4,195 |
| Saint Lucia | 4,587 | 512 | 3.4 | 3.5 | 5,004 |
| Montserrat | 6,753 | 1,122 | 2.9 | 7.9 | 7,656 |
| Saint Kitts & Nevis | 7,226 | 1,313 | 5.8 | 3.4 | 8,237 |
| Barbados (1995–2004)[a] | 8,394 | 950 | 4.3 | 4.3 | 9,669 |
| Antigua & Barbuda | 9,050 | 1,281 | 8.7 | 3.7 | 9,988 |
| Anguilla | 10,370 | 2,914 | 8.7 | 9.4 | 12,360 |
| Curaçao (1996–2006)[b] | 15,848 | 1,385 | 2.2 | 2.7 | 16,865 |
| Bahamas | 17,198 | 2,990 | 6.3 | 6.0 | 18,888 |
| Aruba | 19,859 | 2,366 | 3.6 | 3.6 | 22,009 |
| Turks and Caicos (2008)[c] | n.a. | n.a. | n.a. | n.a. | 24,273 |
| Virgin Islands, British (2005)[d] | n.a. | n.a. | n.a. | n.a. | 37,550 |
| Virgin Islands, US (2007)[e] | n.a. | n.a. | n.a. | n.a. | 39,915 |
| Cayman Islands | 52,896 | 7,416 | 7.6 | 4.6 | 56,274 |
| Bermuda | 57,660 | 16,102 | 8.4 | 9.5 | 70,359 |
| | Countries dollarized with the € | | | | |
| Guadeloupe[f] | 17,256 | 2,760 | 4.5 | 1.4 | 22,896 |
| Martinique | 19,106 | 2,771 | 4.3 | 1.7 | 24,851 |
| Saint Barthélemy (Saint Barths) | n.a. | n.a. | n.a. | n.a. | n.a. |

*Notes*.

[a.] Data on Barbados are for 1995–2004; International Financial Statistics (IFS).

[b.] Data on Curaçao are for 1996–2006; CBS of Curaçao.

[c.] Data on Turks and Caicos are for 2008, Department Economic Planning and Statistics.

[d.] Data on the British Virgin Islands are for 2005 (UN, 2012).

[e.] Data on the US Virgin the Islands are for 2007. (Bureau of Economic Analysis [BEA], n.d.)

[f.] INSEE

Sources: International Financial Statistics.

## 2.4. The Commodity Markets in Curaçao

The data on economic structure show the developments by sector and are used as an indication of the performance of the commodity markets in Curaçao. In addition, the market structure provides insight into the market forms, the market share by sector, whether firms are state owned or privately owned, and whether the prices set by the market forces are administered[15] or regulated by the government.

### 2.4.1. The Economic Structure of Curaçao

Table 2.9 presents the economic structure of Curaçao in the period of 1996−2012.[16] The main shift in the economic structure is the declining share of government in the GDP, from 19.0% in 1996 to 11.4% in 2006. Starting in 1988, the government of Curaçao embarked on a number of restructuring programs to reduce the government apparatus, which was followed by a massive migration (CBCS, 2001). The underperformance in the period of 1996−2006 was probably caused by the adverse demand shock generated by the restructuring of the government.

In the 1996−2012 period, small increases occurred in the "hotel and restaurant" sector, "real estate, renting and business activities," "private education," and the "financial" sector. These increases were related to the increased numbers of visitors and the "penshonado facility" for European citizens acquiring a second home in the Caribbean, among other things (Baker Tilly International, 2009, p. 13). The "financial sector," "the government," and "trade" remained the main sectors, which is an indication of a lack of further diversification in the economic structure in this period. Similar to other Caribbean micro-islands, the financial sector is one of Curaçao's

[15] Administered prices are set at sellers' discretion according to some rules or judgements (Ackley, 1959, p. 421).

[16] The data from 1996 to 2006 are from the National Accounts and the 2011 and 2012 data are estimates produced by the CBS. The classification systems are follow the system of National Accounts of 1993 (SNA93) and the international standard industrial classification (ISIC, Revision 3).

main economic activities. Unlike most other Caribbean micro-islands, the government sector, instead of the tourism sector, is the second largest economic activity (as % of the GDP). The tourism sector, approximated by the "hotel and restaurants" sector, has a moderately small share (approximately 3.7% of the GDP) in Curaçao.[17]

To summarize, the two main sectors in the economy of Curaçao are the financial sector and the government, whereas most other Caribbean micro-islands have the financial sector and tourism as their main sectors. In addition, in contrast to sustainable growth rates on the Caribbean micro-islands within the period of 1995–2006, Curaçao reported low growth rates. The underperformance in Curaçao was probably the result of the demand shock caused by the public sector restructuring that started in the late 1980s. As output has been reduced, this implied smaller commodity markets.

Table 2.9

*The Gross Domestic Product by Sector in Curaçao (% of Total GDP for 1996, 2001, 2006, 2011, 2012)*

| ISIC sections[a] | Non-financial corporations | 1996 | 2001 | 2006 | 2011[b] | 2012[b] |
|---|---|---|---|---|---|---|
| A+B+C | Agriculture, fishing, & mining | 0.4 | 0.8 | 0.5 | 0.6 | 0.5 |
| D | Manufacturing | 8.9 | 8.0 | 7.8 | 7.9 | 7.9 |
| E | Electricity, gas, & water | 4.0 | 4.7 | 3.8 | 3.5 | 3.4 |
| F | Construction | 5.3 | 4.7 | 4.8 | 5.3 | 5.0 |
| G | Trade | 12.1 | 12.0 | 10.3 | 11.0 | 11.3 |
| H | Hotels & restaurants | 2.5 | 2.8 | 3.0 | 3.5 | 3.7 |
| I | Transport, storage, & communications | 9.0 | 8.5 | 7.8 | 8.2 | 8.6 |
| K | Real estate, renting, & business activities | 5.5 | 7.7 | 7.0 | 6.9 | 6.7 |
| M | Education (private) | 0.1 | 0.2 | 0.5 | 0.5 | 0.5 |
| N | Health & social work | 2.9 | 4.3 | 4.1 | 4.2 | 4.0 |
| O | Other community, social, & personal service activities | 1.7 | 2.8 | 3.5 | 3.3 | 3.2 |
| | Value added, gross, market prices | 52.3 | 56.5 | 53.1 | 54.8 | 54.9 |

[17] In terms of revenues received from exports, the financial sector and tourism are the two main export sectors in Curaçao.

Table 2.9

*The Gross Domestic Product by Sector in Curaçao (% of Total GDP for 1996, 2001, 2006, 2011, 2012)*

| | | | | | | |
|---|---|---|---|---|---|---|
| | | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Financial corporations | | | | | |
| J | Financial intermediation | 16.3 | 16.9 | 18.9 | 17.6 | 17.8 |
| | Value added, gross, market prices | 16.3 | 16.9 | 18.9 | 17.6 | 17.8 |
| | | | | | | |
| | Government | | | | | |
| A+B | Agriculture | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| I | Transport, storage, & communications | 0.7 | 0.3 | 0.2 | 0.3 | 0.3 |
| K | Real estate, renting, & business activities | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 |
| L | Public administration & defense; compulsory social security | 8.7 | 6.3 | 7.0 | 6.5 | 6.3 |
| M | Education | 4.3 | 1.3 | 1.7 | 1.9 | 1.9 |
| N | Health & social work | 2.5 | 1.6 | 1.3 | 1.6 | 1.6 |
| O | Other community, social, & personal service activities | 2.5 | 1.0 | 1.0 | 1.2 | 1.1 |
| | Value added, gross, market prices | 19.0 | 10.6 | 11.4 | 11.6 | 11.3 |
| | | | | | | |
| | Households & non-profit institutions serving households | | | | | |
| A+B | Agriculture & fishing | 0.0 | 0.0 | 0.0 | n.a. | n.a. |
| D | Manufacturing | 0.0 | 0.0 | 0.0 | n.a. | n.a. |
| F | Construction | 0.1 | 0.0 | 0.0 | n.a. | n.a. |
| G | Trade | 0.1 | 0.2 | 0.3 | n.a. | n.a. |
| H | Hotels & restaurants | 0.1 | 0.1 | 0.2 | n.a. | n.a. |
| I | Transport, storage, & communications | 0.4 | 0.4 | 0.4 | n.a. | n.a. |
| K | Real estate, renting, & business activities | 5.6 | 7.5 | 7.8 | n.a. | n.a. |
| N | Health & social work | 0.0 | 0.0 | 0.0 | n.a. | n.a. |
| O | Other community, social, & personal service activities | 0.4 | 0.4 | 0.3 | n.a. | n.a. |
| P | Private households | 0.3 | 0.3 | 0.3 | n.a. | n.a. |
| | Value added, gross, market prices | 7.1 | 9.0 | 9.4 | 8.5 | 8.5 |
| | Total value added, gross, market prices | 94.8 | 93.0 | 92.7 | 92.5 | 92.4 |
| | Plus taxes less subsidies on products | 7.8 | 9.6 | 9.7 | 10.2 | 10.3 |
| | Minus Fisim[c] | 2.6 | 2.6 | 2.4 | 2.7 | 2.7 |
| | Domestic product, gross, market prices | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Table 2.9

*The Gross Domestic Product by Sector in Curaçao (% of Total GDP for 1996, 2001, 2006, 2011, 2012)*

*Notes.*
[a.] ISIC is the acronym for International Standard Industrial Classification for all economic activities (ISIC, Revision 3).
[b.] Estimates.
[c.] Fisim: Financial intermediation services indirectly measured.
Source: Centraal Bureau voor de Statistiek, National Accounts.

### 2.4.2. The Market Structures in Curaçao

Table 2.10 presents an overview of the classification of the economic sectors by market structure in Curaçao. For each sector, the market structure provides information on the degree of competitiveness, whether firms cooperate or engage in collusive behavior, or whether firms are price setters/price takers. This information is valuable in the assessment of the functioning of the commodity markets. In the table, Column 1 shows the classification system of the ISIC, Revision 3, and Column 2 presents the corresponding economic sectors. The three most common market structures in Curaçao, which are the imperfect competitive markets of monopoly, oligopoly, and monopolistic competition, are presented in Columns 3 to 5, and the concentration ratios are shown in Column 6. The concentration ratio is measured by the fraction of total sales controlled by the largest group of firms (Lipsey et al., 1991, p. 264). The threshold value for the concentration ratio is set at Q4, the market share of the four largest companies.

The first market form in Column 3 is the monopoly. A monopoly is when the output of the industry is sold by a single firm (Lipsey et al., 1991, p. 245). Monopolies on a micro-island are not uncommon, as more than one production unit in a sector of a micro-island is often not economically feasible, which creates natural monopolies.[18] Curaçao has many natural monopolies. In the "manufacturing" sector, the following state monopolies are operating: the

[18] A natural monopoly is when the cheapest way to produce at any level of output is by having a single firm that produces the goods or services.

"Refineria di Kòrsou N.V." (leasing of the oil refinery), the "Refineria Isla" (oil refining), and the "Curaçao Dry-dock Company" (dry docking). The Venezuelan multinational, PDVSA, leases the Refineria Isla, which produces oil derivatives. The "energy" sector has the state monopolies of "Aqualectra N.V." (water and electricity production and distribution), "Curoil N.V." (sales of oil and oil derivatives), and "Curgas N.V." (distribution of household gas). All monopolies with the exception of "Mijnmaatschappij" (mining) and Refineria Isla are state-owned companies. The government regulates the price setting in all of the state-owned companies (P. B. No. 203, 1982; P. B. No. 44, 1995), excluding the Curaçao Dry-dock Company. The price setting of Refineria Isla and the Dry-dock Company is determined in the international markets. The price setting of sand and bricks produced by Mijnmaatschappij is regulated. "Curaçao Ports Services" is a privately owned company with a monopoly concession on stevedoring.

The second market form in Column 4 is the oligopoly. An oligopoly contains two or a "few" firms, where at least one produces a significant proportion of the industry's total output. The threshold of a "few" firms in an oligopoly may vary between 3 and 12 firms (Lipsey et al., 1991). To classify the industry by oligopoly in this dissertation, the maximum of 12 firms has been applied. Oligopolistic markets usually have high concentration ratios. Firms in oligopolistic markets cooperate or engage in tacit collusive behavior. Tacit collusion is when firms agree to cooperate to restrict output and/or raise prices (Lipsey et al., 1991). The "air transportation" sector in Curaçao has an oligopolistic market structure with few firms, mostly comprising foreign-based companies. The airline companies differ in the provided services in relation to comfort, possibility of connecting flights, and whether flights are scheduled daily or only on specific weekdays. The air transportation can be partitioned into transatlantic flights,

flights to the US, regional flights, and flights between the former islands of the Netherlands Antilles. On January 1, 2012, a new air transportation policy between the countries of the Kingdom of the Netherlands was agreed on (Protocol 2011, 2011). The price setting in air transportation is based on "commercial considerations in the market place," Article 13 of the Protocol 2011 (2011)) and collusive behavior is not permitted.

"Sea transportation" is mainly used for transportation of goods in containers. Most containers arrive full of merchandise, but they are freightless from Curaçao to their next port (Curaçao produces mainly services). This market is oligopolistic, with four large feeders owned by mainly foreign companies, and the prices are set internationally (D. Cloose, personal communication, March 26, 2015). Another important sector is the financial sector. In the banking sector there is one dominant player, Q1, with 50% of the market share (Department of Economic Affairs, "Dienst Economische Zaken" [DEZ], 2004). The price setting in the banking sector is likely to be determined by the dominant party, which is the Maduro & Curiels Bank.

Table 2.10

*Sectors by Market Structures and the Concentration Ratio in Curaçao in 2011 and 2012*

| ISIC (1) | Economic sectors (2) | Monopoly (3) | Oligopoly (4) | Monopolistic competition (5) | Concentration ratio (6) |
|---|---|---|---|---|---|
| A+B+C | Agriculture, fishing, & mining | Mijnmaatschappij N.V. | | Small agricultural businesses and fishermen | |
| D | Manufacturing | Curaçao Dry-Dock N.V., Refineria di Kòrsou N.V., Refineria Isla | | Branch of food, beverage, tobacco<br>Branch of textile, leather, wood, paper, cartons | Q4 in the branch of food, beverage, tobacco has 51%<br>Q4 of the branch of leather, wood, paper, cartons has 68% |
| E | Electricity, gas, & water | Aqualectra N.V., Curgas N.V, Curoil N.V. | | | |
| F | Construction | | Infrastructural works: 5 firms [a] | Civil engineering[b]<br>Constructors[c,d] | Q4 has 68% |
| G | Trade | Curinde N.V. | | Supermarkets[e], tokos, minimarkets<br>Pharmaceuticals importers: [f] | Q4 of the supermarkets, tokos has 43%<br>Q4 has 65% |
| H | Hotels & restaurants | | | Hotels, apartments, & villas[g], small restaurants | Q4 of the hotels apartments has 51% |

Table 2.10

*Sectors by Market Structures and the Concentration Ratio in Curaçao in 2011 and 2012*

| | | | | | |
|---|---|---|---|---|---|
| I | Transport, storage & communications | Air transportation: Curaçao Airport Holding N.V. Air transportation route: Curaçao-Sint Maarten Sea transportation: Curaçao Port Authority, Kompania di Tow Kòrsou (towing), Curaçao Port Services N.V. (stevedoring) | Air transportation by route maximum of 7 airlines [h] Air freight transportation: maximum of 2 airlines[i] Sea freight by route: maximum of 4 mainly foreign firms [j] Communication: Cable providers: 4 providers [k] Internet providers and mobile, phones: 4 providers [l] | Public transportation: Autobusbedrijf Curaçao N.V. and many small busses | Air/sea transportation branch: foreign firms operate Public transportation branch: Q4 has 70% Storage branch: Q4 has 66% Information and communication branch: Q4 has 59% |
| J | Financial intermediation | Korpodeko | Domestic banking sector: 7 firms[m] | | In the domestic banking sector, Q1 has 50% (DEZ, 2004) |
| K | Real estate, renting and business activities | | | Many consultancy and accountants, lawyers offices; real estate offices | |

Table 2.10

*Sectors by Market Structures and the Concentration Ratio in Curaçao in 2011 and 2012*

| | | | | |
|---|---|---|---|---|
| L | Public administration & defense; social security | Fundashon Kas Popular | | |
| M | Education | | Private universities and private schools: maximum of 6[n] Hospitals: 4 entities[o] | Q4 has 56% |
| N | Health & social work | Sociale Verzekeringsbank | Laboratories: 5 entities[p] | |
| O | Other community, Social and personal service activities | Selikor N.V. | Small businesses, e.g., barbershops, spas, nail care, day care | |

Table 2.10

*Sectors by Market Structures and the Concentration Ratio in Curaçao in 2011 and 2012*

*Notes*. Classification of firms according to the ISIC, Revision. 3.

Source: Construction sector (S. van Rijn, personal communication, March, 16, 2015):

[a.] Infrastructure works: Janssen de Jongh, CWM, MNO Vervat, Alianza.

[b.] Civil engineering: Ballast Nedam, Curcon, NAB, BWC, Betonbouw, and many others in wood works and painting firms.

[c.] Constructors mainly work for the refinery: de Ron Machine Shop, Nederex, MITS, and many other small firms.

[d.] Other constructors dealing with installations and technical support.

[e.] Supermarkets: 2000, Albert Heijn, Alves, Arco Iris, Artis, Best Buy, Boulevard Market Place, California, Centrum Supermarket, Cost U Less, Esperamos, Exito, Goisco, Mangusa, San Pedro, Vreugdenhil.

[f.] Pharmaceuticals importers are at least 13 firms and the concentration ratio of Q4 is 65%. Source: J. Barton, personal communication (March, 25, 2015)

[g.] Tourism. Source: Website Curaçao Tourism Board. There are 25 registered hotels, of which 2 have fewer than 20 rooms, 6 have 20–50 rooms, 7 have 50–100 rooms, 4 have 100–200 rooms, and 6 hotels have more than 200 rooms. The number of registered apartments and villas are 34 and 18, respectively.

[h.] Air travel transportation (Source Curaçao Airport Holding [CAH], personal communication, March 1, 2015): Route *Curaçao–US*: American Airlines, Insel Air, Jet Blue, Miami Air (charter); Route *Curaçao-Canada*: Air Canada, West Jet, Sunwing (charters); Route: *Curaçao–South America*: Avianca, Surinam Airways, Insel Air, Copa Airlines, Estelar, Rutaca, Avior; Route *Curaçao –Bonaire*: Divi Divi Air, Insel Air Route *Curaçao–Sint Maarten*: Insel Air; Route *Curaçao–Netherlands*: KLM, Arkefly; Route *Curaçao–Dusseldorf*: Air Berlin.

[i.] Air Freight (Source: CAH, personal communication, March 1, 2015): Route *Curaçao–US*: AmeriJet, Ameriflight; Route *Curaçao–South America*: DHL, LAS, Aerosucre; Route *Curaçao–Europe*: see air travel transportation.

[j.] Sea transportation sector: Route *US –Curaçao*: 4 feeders (of containers): Caribbean Feeder Services, Seafreight, Seaboard, King Ocean; Route *Transatlantic–Curaçao*; Spliethof, Seatrade; Route: *Venezuela–Curaçao* (2 firms); Route *Bonaire–Curaçao*: Don Andres (1 firm). Source: D. Cloose, personal communication (March 26, 2015).

[k.] Communication sector: Cable providers: Flow, Direct TV, Tres Network, TDS.

[l.] Internet providers and mobile phones: UTS, Digicel, Flow, Tres Network (no mobile).

[m.] Financial intermediation: Domestic banking sector: Banco di Caribe, Maduro Bank, Orco Bank, SFT bank, Giro Bank, RBC Bank, Postbank. Source: Department of Economic Affairs (2004).

[n.] Education: Universities: UDC, UoC, ICUC,St. Martinus University, Caribbean International University, Avalon, Nashko. Private secondary schools: International School, Abel Tasman College, Schroeder, Omega, Vespucci.

[o.] Health: Hospitals: Advent ziekenhuis, Kraamkliniek, Taams kliniek, ‘ Sint Elisabeth hospital (Sehos).

[p.] Laboratories: Advent, ADC, Lab de medicos, Medial laboratory services, Laboratory of the “Sint Elisabeth” Hospital

Source: Author’s compilation and CBS.

The third market form, monopolistic competition, is when there are many sellers with product differentiation, and easy entry and exit of firms. In the "tourism" sector, the hotels, apartments, and villas have a monopolistic competitive market structure. The hotels have differentiated products and are competing in the tourist markets of Europe, the United States, and Latin America. The price setting of the hotels is determined largely by the quality of the product (often based on whether it is a chain hotel or an independent hotel). As there is product differentiation in the accommodation of the tourism sector, this sector is less likely to cooperate in price setting; hence, tacit collusion is less likely.

The "trade" sector can be partitioned into import/wholesale and retail. A few importers are also retailers. The "retail trade" is best described through a street scene in a neighborhood. On every street corner, a small grocery shop/convenience store (also called a *toko*, *tienda*, or minimarket) is present, adjacent to a snack bar. The number of firms in the retail sector is large, and the products are differentiated. Hence, retailers operate in a monopolistic competition structure. In these grocery shops, clients "walk in," as the stores cater mainly to the neighborhood and those in walking distance. The larger supermarkets are fewer in number (see note [e] in Table 2.10) and are organized in the Curaçao supermarkets association, (SUVECU).

The supermarkets carry a larger variety of goods and are cheaper than the tokos/minimarkets. Nonetheless, the tokos have some advantages compared to the supermarkets. The tokos are easily accessible, and as a result, they are frequently visited by the elderly. The owner and client have a long-term relationship and may even be on a first-name basis. In addition, for a small errand, the nearest store is a toko. Tokos have longer business hours than the larger supermarkets, and they are usually open on holidays. The latter is explained by the fact that most tokos are family businesses.

In the trade sector, selected food items are regulated (P. B. No. 117, 1961; P. B. No. 76, 1965). Price regulation in this sector is based on a maximum markup. The prices of the nonregulated goods are set by a markup on the import prices (J. Gois, personal communication, May 27, 2015). Hence, these prices in the trade sector are administered. Moreover, tacit collusion in supermarkets' price setting has been reported (Koek, 2014). Two other sectors also reported to have tacit collusion are the "construction" sector and the branch of importers of pharmaceuticals (Koek, 2014). Both sectors have high concentration ratios and tacit collusion. The Q4 of the construction sector is 68%. The branch of importers of pharmaceuticals has a Q4 of 65% (J. Barton, personal communication, March 25, 2015). In the latter branch, the prices of some selected medicines are regulated (P. B. No. 28, 2012; P. B. No. 40, 2014).

## 2.5. Conclusions

Caribbean micro-islands have very small populations, each with less than half a million inhabitants. Consequently, their commodity markets are small. Although the economic cooperation of the OECS and CARICOM has extended the commodity markets of 14 of the Caribbean micro-islands, in the absence of inter-island freight and personal transportation, and given the lack of comparative advantage (micro-islands tend to specialize in similar exports), the benefits of a larger internal market of the micro-islands remain unexploited. As a result, the costs of production of these small islands remain high. Next to the high production costs are the high import-to-GDP ratios. Micro-islands are therefore highly dependent on sea and air transportation, and these costs tend to be relatively higher than in larger economies (Winters, 2005). Micro-islands tend to have low domestic inflation rates, the result of dollarization or pegs to the US dollar.

Caribbean micro-islands are price takers, and their domestic prices are expected to be flexible. However, the observed sticky prices in Curaçao invite a more in-depth analysis. Thus, the aim of this chapter was to pinpoint factors that may explain why the domestic prices of Curaçao deviate from the international prices.

The factors considered were inflation, collusive behavior, high concentration ratios, and price regulation. Inflation causes wages to rise, which affects future domestic price adjustment. Hence, inflation is a factor that may cause the domestic prices to deviate from the international prices. According to the theory of collusive behavior, particularly in oligopolistic markets, such behavior of firms brings about sticky domestic prices. In addition, a low degree of market competition is associated with less frequent change in prices and even sticky prices. Following the next hypothesis, concentration ratios of the Q4 are used as a measure for a low degree of market competition. Finally, according to the price regulation hypothesis, this keeps the price fixed for a period of time, possibly leading to sticky prices. Sticky prices imply that the domestic prices are not following the international prices, causing the domestic prices to deviate from the international prices.

Inflation, the collusive behavior of firms, concentration ratios of the Q4, and price regulation are factors that lead domestic prices to diverge from international price setting. Inflation affects how often prices change, and it is a variable in the state-dependent pricing hypothesis. The collusive behavior of firms, high concentration ratios of the Q4, and price regulation are sources of price rigidity in the various price-rigidity hypotheses. These factors are analyzed and tested in chapters 3, 4 and 5.

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# CHAPTER 3

# STICKY PRICES ON A CARIBBEAN MICRO-ISLAND

Small islands are price takers, and they are assumed to have flexible prices. The "price-flexibility hypothesis" implies that domestic prices instantaneously change following an adjustment in the world market price. The assumption of flexible prices in these economies has remained uncontested, as only recently were data on price adjustment in small Caribbean islands published in a report (CCMF, 2011).[19] This report contained data on price adjustment of five small Caribbean islands, including three micro-islands. The micro-islands of Barbados and Saint Lucia reported frequent price changes, while Curaçao showed infrequent price changes.

Given the frequent adjustments of import and export prices in Curaçao, the domestic price changes are expected to follow these movements. This is explained as follows. A change in import prices affects the costs of the inputs of production, and these costs will be passed on through domestic prices. Changes in export prices will also be passed on through domestic prices. Doing otherwise may result in a loss of competitiveness. However, since domestic price changes in Curaçao are rather infrequent, the expected price flexibility is contradicted. Hence, sticky prices in Curaçao create a puzzle that needs further analysis. Therefore, the aim of this chapter is to elaborate on the characteristics of price adjustments in Curaçao. The analysis is based on the stylized facts concerning how often prices change and on the rigidity of prices. Such data contribute to the matching of the relevant price-rigidity theories to this price-rigidity puzzle. In addition, they provide evidence concerning the magnitude of price adjustments in Curaçao.

[19] The participating countries were as follows: Barbados (Craigwell, Winston, & Worell, 2011), Curaçao (Carolina, 2011), Guyana (Ganga, 2011), Trinidad and Tobago (Mahabir & Jagessar, 2011), and Saint Lucia (Polius and St. Catherine, 2011).

Price adjustments have high or low frequencies. A high frequency corresponds to flexible prices, as prices change often; meanwhile, a low frequency means that prices change rarely and prices are sticky. In the literature on price adjustment, the distinction between sticky and flexible pricing is arbitrary; hence, a benchmark is necessary to define sticky prices. The benchmark used in this chapter is based on international studies that have categorized prices to be either sticky or flexible. With this benchmark, it is possible to distinguish sticky from flexible prices and test whether the prices in Curaçao comply with the price-flexibility hypothesis.

The statistics of price change frequency and the duration of price spell, which is the period wherein prices remain unchanged, are calculated using micro-data from the commodity markets. Micro-data include the data collected to produce the CPI, the producer price index (PPI), surveys sent to firms asking about price setting, scanner data (data using the bar code of the product and other information about the product), or online price data (price data of firms operating on the Web). In this chapter, I use the CPI data, which have been compiled from the national statistical agencies, to measure the frequency and size of price adjustments.

The chapter is organized as follows. Section 3.1 discusses the literature on price adjustment and derives a benchmark for the distinction between sticky and flexible prices. This benchmark is used as the yardstick to measure whether prices are sticky or flexible in Curaçao. The stylized facts on the pricing behavior in Curaçao are presented in Section 3.2, and Section 3.3 draws conclusions on the price-rigidity hypothesis, which may (not) apply to Curaçao.

## 3.1. Sticky Versus Flexible Prices

Changing prices immediately after a shock entail a high speed of price adjustment and are indicative of a process with flexible price adjustment. Prices may also be sticky, resulting in infrequent price changes. The speed of price adjustment can be derived either from the price

change frequencies or from the duration of price spells (Álvarez et al., 2005; Bils & Klenow, 2004). In the literature on price adjustment, there are two approaches that are commonly used to measure the frequency of the price change. The first approach employs the micro-data from surveys of firms. This approach was pioneered by Blinder (1991, 1994, 1998) for randomly selected US firms. The question asked to the US managers in Blinder (1994) was as follows: "How often do the prices of your most important products change in a typical year?" (p. 120). This method provides an *approximation* of the frequency of price adjustment, as the answers are based on a firms' interpretation on how often prices of their most important products have changed. The second approach is calculated from CPI or PPI micro-data. The latter approach is preferred, as in contrast to the former, it measures the price change frequency based on a large sample of reported data. In this chapter, CPI-based price change frequencies are applied, mainly because on micro-islands, only CPI micro-data are available. The price change frequency of a product or service is defined as the fraction of price changes within a given month.

A theory-based benchmark for the classification of sticky and flexible prices is nonexistent; hence, the distinction between the two is unclear. According to Blinder (1991, p. 90), the concept of sticky prices is often used to define a process of price adjustment that occurs "less rapidly" than the Walrasian market-clearing prices. However, the term "less rapidly" is not defined, and the Walrasian equilibrium prices are unknown; hence, there is no norm for market-clearing prices (Blinder, 1991, p. 90). This implies that it is difficult to measure whether prices are moving fast or slowly or distinguish sticky from flexible prices unambiguously. My approach is to use a sample of studies including CPI-based price change frequencies that qualify the price adjustments as sticky. As a low mean price change frequency marks stickiness, an upper bound threshold value is needed. Price change frequencies below this threshold value will

be considered sticky. In small developing economies, flexible prices are expected, and sticky prices are more likely to occur in larger economies. Hence, for the setting of a benchmark for sticky prices, the literature of the larger economies is reviewed.

Most national statistical agencies, including the US Bureau of Labor Statistics and the departments of statistics in the euro area, started to share the micro data of the CPIs with their respective national researchers in the late 2000s (Bils & Klenow, 2004). With this supply of micro-data, a large amount of literature on price adjustments that uses the methodology described in Dhyne et al. (2005) to calculate the (sizes of) price change frequencies has been produced. I categorize the countries by the level of development determined by the United Nations Development Programme (UNDP) classification system as of February 2011 (Nielson, 2011).

Table 3.1 shows the price change frequencies in developed economies, partitioned into European countries and other Organisation for Economic Co-operation and Development (OECD) countries. The European countries are categorized in the euro area and other European countries. The sample period listed in the second column differs by country and depends on the availability of data provided by the national statistical agencies. The longest sample period is 30 years, reported by Norway, while the shortest is 2 years, reported by Israel. The average price change frequencies (Columns 3 and 4) and the median price change frequencies (Columns 5 and 6) of all CPI categories, excluding dwellings, are listed. Price change frequencies are measured by the type of prices. The types of price are as follows: the posted prices, which are the published prices (sale and non-sale or discounted prices); and the regular prices, which consist of non-sale prices. In the studies of Austria, Norway the United Kingdom, and the United States, the price change frequencies of both regular and posted prices are listed.

Table 3.1

*Frequencies of Price Changes in the Total of CPI Categories in the Developed Countries (Period Averages in Percentage of Months, Excluding Rent)*

| Country/countries | Sample period | Frequency (in % of months) | | Frequency (in % of months) | |
|---|---|---|---|---|---|
| | | Mean | | Median | |
| | | Posted | Regular | Posted | Regular |
| (1) | (2) | (3) | (4) | (5) | (6) |
| | | The Euro area: | | | |
| Italy[a] | 1996.01−2003.12 | 8.8 | | | |
| Germany[b] | 1998.01−2004.01 | 10.0 | | | |
| Spain[c] | 1993.01–2001.12 | 15.0 | | | |
| Austria[d] | 1996.01−2003.12 | 15.1 | 12.8 | n.a. | n.a. |
| Netherlands[e] | 1998.11−2003.04 | 16.5 | | 17.9 | |
| Belgium[f] | 1989.01−2001.01 | 16.9 | | n.a. | |
| Luxembourg[g] | 1999.01−2004.12 | 17.0 | | | |
| France[h] | 1994.07−2003.02 | 18.9 | | 14.9 | |
| Finland[i] | 1997.01−2003.12 | 17.0/20.0 | | 4.8/5.6 | |
| Portugal[j] | 1992.01–2001.01 | 22.0 | | 11.7 | |
| | | Other European countries | | | |
| Denmark[k] | 1997.01−2005.12 | 17.3 | n.a. | 11.8 | n.a. |
| United Kingdom[l] | 1996.01−2006.01 | 19.0 | 15.0 | n.a. | n.a. |
| Norway[m] | 1975.01−2004.12 | 21.9 | 21.3 | 14.3 | 13.0 |
| | | Other OECD countries | | | |
| Japan[n] | 1999.01−2003.12 | 21.4 | n.a. | n.a. | n.a. |
| Israel[o] | 1991.01−1992.12 | 24.5 | n.a. | 20.0 | n.a. |
| United States[p] | 1995.01−1997.12 | 26.1 | 23.6 | 20.9 | n.a. |
| United States[q] | 1988.02−2005.01 | 36.2 | 29.9 | 27.3 | 13.9 |
| United States[r] | 1998.01−2005.12 | 27.2 | 21.1 | 20.5 | 8.7 |

Table 3.1

*Frequencies of Price Changes in the Total of CPI Categories in the Developed Countries (Period Averages in Percentage of Months, Excluding Rent)*

*Notes.*

[a.] Source: Veronese, Fabiani, Gatulli and Sabbatini (2005). Posted prices.
[b.] Source: Hoffmann and Kurz-Kim (2005).
[c.] Source: Alvarez and Hernando (2006). Posted prices only, excluding tobacco, rents, energy, telecommunications, car, hotels, and services.
[d.] Source: Baumgartner, Glatzer, Rumler, and Stiglbauer (2005).
[e.] Source: Jonker, Folkertsma and Blijenberg (2004). Posted prices. Double weighted sample.
[f.] Source: Aucremanne and Dhyne (2004). Posted prices only.
[g.] Source: Lunnemann and Matha (2005). Posted prices only.
[h.] Source: Baudry, Le Bihan, Sevestre and Tarrieu (2004). Posted prices only.
[i.] Source: Vilmunen and Laakkonen (2004). Posted prices only. The data are from the two samples: pre- (17%) and post-2000 (20%) data.
[j.] Source: Dias, Dias and Neves (2004). Posted prices only.
[k.] Source: Hansen and Hansen (2006). Posted prices only.
[l.] Source: Bunn and Ellis (2009), the posted price data include all prices, the regular price data exclude temporary discounts.
[m.] Source: Wulfsberg (2009). Posted prices and regular prices (posted price excluding sales).
[n.] Source: Saita and Higo. (2007). Posted prices only.
[o.] Source: Baharad and Eden (2003). Posted prices only.
[p.] Source: Bils and Klenow (2004). Posted prices only.
[q.] Source: Klenow and Kryvtsov (2008). Posted and regular prices.
[r.] Source: Nakamura and Steinsson (2008). The CPI data are the revised data of the Bureau of Labour Statistics. The revision included data starting 1998. The posted price data include both sales and substitution, the regular price data exclude sales and substitutions.

The European central banks compiled an impressive list of studies on price adjustment in the euro area under the umbrella of the Inflation Persistence Network (IPN; Dhyne et al., 2005). In the IPN studies, price change frequencies were mainly calculated on posted prices. The results for the two categories of European countries (the euro area and other European countries) are shown in Table 3.1. The IPN studies of the euro area also reported that the price change frequencies in the different categories of the CPIs were heterogeneous, with both low and high price change frequencies (Dhyne et al., 2005). European countries outside the euro area reported similar results (Bunn & Ellis, 2009; Hansen & Hansen, 2006; Wulfsberg, 2009). Table 3.1 shows that the mean price change frequency was lower than 22% in the European countries.

Most of the countries classified as other OECD countries reported higher mean posted prices than the European countries. It is worth mentioning that the first extensive study using the complete "non-housing" commodities (excluding dwellings/rental fees) was carried out by Bils and Klenow in 2004; they used monthly US CPI data for the period of 1995 to 1997. This was followed by studies on price adjustment in the United States by Klenow and Kryvtsov (2008) and Nakamura and Steinsson (2008). These studies differ in the sample periods, the use of CPI or PPI data, or both, as well as in the regional areas of the sample. The studies on the United States and those on countries in the "other OECD" group, namely Japan (Saita & Higo, 2007) and Israel (Baharad & Eden, 2003), reported heterogeneous price frequency adjustment, which means that there are high and low price change frequencies across the CPI categories. In addition, in the non-euro area (the other European and other OECD countries), the mean is higher than the median.

To conclude, price frequency adjustments in the developed countries have been reported as heterogeneous. As shown Table 3.1, particularly in the non-euro area, the mean is higher than the median. This means that the mass lies to the left, with the "tail" toward the right (right-skewed distribution).

Table 3.2 shows selected Latin American, African, and Caribbean developing countries that reported their (posted) price change frequencies. Of this group, only South Africa reported a low mean price change frequency of 15.9% of months. In general, the Latin American and Caribbean countries reported comparatively higher price change frequencies than the developed countries listed in Table 3.1.

Table 3.2

*Frequencies of Price Changes in the Total of the CPI Categories in the Developing Countries (Period Averages in Percentage of Months, Excluding Rent)*

| Country | Sample period | Frequency (in % of months) | Frequency (in % of months) |
|---|---|---|---|
| | | Mean posted | Median posted |
| (1) | (2) | (3) | (4) |
| | Latin American countries | | |
| Brazil[a] | 1996.01−2006.12 | 37 | n.a. |
| Chile[b] | 1999.01−2005.07 | 46.1 | 33.3 |
| | African Countries | | |
| South Africa[c] | 2001.12−2006.02 | 15.9 | n.a. |
| Sierra Leone[d] | 1999.01−2003.04 | 51.5 | |
| | Caribbean countries (CCMF, 2011) | | |
| Barbados[e] | 1994.01−2008.12 | 50–80 | n.a. |
| Trinidad & Tobago[f] | 2004.01−2010.12 | 1–90 | n.a. |
| Guyana[g] | 1994.01−2004.12 | 98.4 | n.a. |
| Saint Lucia[h] | 1984.04−2008.01 | 98 | n.a. |

*Notes.*

[a.] Source: Gouvea (2007). Posted prices only.

[b.] Source: Medina, Rappoport, and Soto (2007). Posted prices only.

[c.] Source: Creamer and Rankin (2008). Posted prices only.

[d.] Source: Kovanen (2006). Posted prices of food items only.

[e.] Source: Craigwell et al. (2011). The data present the range of price change frequencies on the 1 digit COICOP level. Posted prices only.

[f.] Source: Mahabir and Jagessar (2011). The data present the range of price change frequencies. Posted prices only.

[g.] Source: Ganga (2011). Posted prices only.

[h.] Source: Polius and St. Catherine (2011). Posted prices only.

In both developed and developing countries, heterogeneity in price change frequencies across product categories has been reported. In most of the reported Latin American and Caribbean countries, price changes occurred more frequently compared to the developed countries. This indicates a higher flexibility of prices in these economies.

The counterpart of the price change frequency is the duration of the price spell. This is the period wherein prices remain unchanged; it is calculated as the inverse function of the price change frequency. The duration of price spell data for developed and developing countries are shown in Tables 3.3 and 3.4, respectively. The duration of regular prices is longer than that of posted prices, as sales are not included in the regular prices; therefore, it takes longer for regular prices to change when compared to posted prices. The duration of price spell in the developed countries is also longer than in most developing countries, reflecting more frequent price changes in the latter.

Both the duration of price spell and the price change frequency provide similar conclusions on the degree of price flexibility (Alvarez & Hernando, 2006). A short duration is equal to high price change frequency, which is similar to a high speed of price adjustment. However, the use of the data on duration of the price spell to measure the benchmark for sticky versus flexible prices has the disadvantage that there are three methods of calculating the duration of price spell for the aggregated CPI categories; hence, the calculation is ambiguous. Two of these methods assume discrete calculations,[20] while one assumes continuous[21] price setting. Let $F_j$ be the price change frequency of sector $j$. The first discrete method is the inverse of the expectation of price frequencies ($1/\mathrm{E}F_j$), while second discrete method is the expectation of inverse of the price change frequency ($\mathrm{E}\,(1/F_j)$). The third method, the calculus of duration of price spell, assumes a continuous price setting of $-1/(ln(1-Fj))$.

[20] The price adjustments using the discrete assumption are reported in months only.

[21] The price adjustments using the continuous assumption are reported in (a combined form of) days, weeks, months, and years.

Table 3.3

*Duration of the Total of the CPI Categories in the Developed Countries (Period Averages in months, Excluding Rent)*

| Country | Sample period | Duration (in months) | | Duration (in months) | |
|---|---|---|---|---|---|
| | | Mean | | Median | |
| | | Posted | Regular | Posted | Regular |
| (1) | (2) | (3) | (4) | (5) | (6) |
| | | The Euro area | | | |
| Italy[a] | 1996.01−2003.12 | 10.8 | | | |
| Germany[b] | 1998.01−2004.01 | | | | |
| Spain[c] | 1993.01−2001.12 | 6.7 | | | |
| Austria[d] | 1996.01−2003.12 | 14.1 | 16.1 | 11.1 | 14.0 |
| Netherlands[e] | 1998.11−2003.04 | 9.7 | | 8.7 | |
| Belgium[f] | 1989.01−2001.01 | n.a. | | 13.3 | |
| Luxembourg[g] | 1999.01−2004.12 | 11.8 | | 8.2 | |
| France[h] | 1994.07−2003.02 | 8.4 | 9.5 | 6.2 | |
| Finland[i] | 1997.01−2003.12 | 4.8–5.6 | | 3.3–3.9 | |
| Portugal[j] | 1992.01−2001.01 | | | 8.5 | |
| | | Other European countries | | | |
| Denmark[k] | 1997.01−2005.12 | 15.5 | n.a. | 11.8 | n.a. |
| United Kingdom[l] | 1996.01−2006.01 | 5.3 | 6.7 | n.a. | n.a. |
| Norway[m] | 1975.01− 2004.12 | 8.1 | 8.4 | 6.5 | 7.2 |
| | | Other OECD countries | | | |
| Japan[n] | 1999.01−2003.12 | n.a. | n.a. | n.a. | n.a. |
| Israel[o] | 1991.01−1992.12 | ..5.8 | n.a. | 4.6 | n.a. |
| United States[p] | 1995.01−1997.12 | 3.3 | n.a. | 4.3 | 5.5. |
| United States[q] | 1988.02−2005.01 | 6.8 | 8.9 | 3.7 | 7.2 |
| United States[r] | 1998.01−2005.12 | 7.7 | 13 | 4.4 | 11 |

Table 3.3

*Duration of the Total of the CPI Categories in the Developed Countries (Period Averages in months, Excluding Rent)*

*Notes.*

[a.]Source: Veronese et al. (2005). The duration is calculated by (1/E$F_j$).
[b.]Source: Hoffmann and Kurz-Kim (2006). Duration is not calculated.
[c.]Source: Alvarez and Hernando (2006). Posted prices only, excluding tobacco, rents, energy, telecommunications, car, hotels, and services. The duration is calculated by (1/E$F_j$).
[d.]Source: Baumgartner et al. (2005). The mean duration is calculated by$-1/(ln(1-Fj))$.
[e.]Source: Jonker et al. (2004). The mean duration is calculated by $-1/(ln(1-Fj))$.
[f.]Source: Aucremanne and Dhyne (2004). Weighted median duration (calculation not shown).
[g.]Source: Lunnemann and Matha (2005). The mean duration is calculated by$-1/(ln(1-Fj))$.
[h.]Source: Baudry et al. (2004). The mean duration is calculated by$-1/(ln(1-Fj))$.
[i.]Source: Vilmunen and Laakkonen (2005). Posted prices only. The data are from the two samples: pre- and post-2000 data. The mean duration is calculated by$-1/(ln(1-Fj))$.
[j.]Source: Dias et al. (2004). The mean duration is calculated by (1/E$F_j$).
[k.]Source: Hansen and Hansen (2006). Posted prices only. The mean duration is calculated by $-1/(ln(1-Fj))$.
[l.]Source: Bunn and Ellis (2009). The posted price data include all prices; the regular price data exclude temporary discounts. The mean duration is calculated by (1/E$F_j$).
[m.]Source: Wulfsberg (2009). Posted prices and regular prices (posted price excluding sales). The mean duration is calculated by $-1/(ln(1-Fj))$.
[n.] Source: Saita et al. (2007). The duration is not calculated.
[o.]Source: Baharad and Eden (2003). Posted prices only. The mean duration is calculated by (1/E$F_j$).
[p.]Source: Bils and Klenow (2004). Posted prices only. The mean duration is calculated by $-1/(ln(1-Fj))$.
[q.]Source: Klenow and Kryvtsov (2008). Posted and regular prices. The mean duration is calculated by (1/E$F_j$).
[r.]Source: Nakamura and Steinsson (2008). The CPI data are the revised data of the Bureau of Labor Statistics. The revision included data starting 1998. The mean duration is calculated by $-1/(ln(1-Fj))$.

The posted price data include both sales and substitutions; the regular price data exclude sales and substitutions. One month is on average 30 days; 10.8 months is equal to 10 months and 24 days.

Empirical studies have selected one of these three methods, and the results of the duration of price spell data are not comparable for a number of reasons. First, there is a discrepancy between the continuous and discrete calculations. Second, there is a discrepancy between the two discrete methods of calculations of the duration (Dhyne et al., 2005). Third, not all countries

produce duration of price spell data; hence, for a comparison between countries, duration data are less appropriate. Instead, the more uniformly defined price change frequencies are more suitable.

The mean and median both measure the central tendency of the data with an unknown distribution, as in the case of the price change frequency. The studies on price change frequency in both developed and developing countries have reported heterogeneity in price adjustments (Bils and Klenow, 2004; Dhyne et al., 2005; CCMF, 2011). With outliers of low and high price change frequencies, the use of the median would be preferred. However, the median is not reported for either the euro countries or the majority of developing countries. Hence, despite its limitations, *posted mean* price change frequencies are used as a benchmark for sticky versus flexible prices.

Table 3.4

*Duration of the Total of the CPI Categories in the Developing Countries (Period averages in months, excluding rent)*

| Country | Sample period | Duration (in months) Mean | Duration (in months) Median |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| | Latin American countries | | |
| Brazil[a] | 1996.01−2006.12 | 2.2 | 1.9 |
| Chile[b] | 1999.01−2005.07 | n.a. | n.a. |
| | African countries | | |
| Sierra Leone[c] | 1999.01−2003.04 | n.a. | n.a. |
| South Africa[d] | 2001.12−2006.01 | n.a. | n.a. |
| | Caribbean countries (CCMF, 2011) | | |
| Barbados[e] | 1994.01−2008.12 | 1.3–1.8 | 0.45–0.86 |
| Trinidad & Tobago[f] | 2004.01−2010.12 | 0.33–114.9 | 0.17–79.7 |
| Guyana[g] | 1994.01−2004.12 | 0.24 | 0.17 |
| Saint Lucia[h] | 1984.04−2008.01 | 0.26 | 0.18 |

*Notes*.

[a.] Source: Gouvea (2007). Posted prices only. The mean duration is calculated by $-1/(ln(1-Fj))$, and the median is $-ln(0.5)/(ln(1-Fj))$.

[b.] Source: Medina et al. (2007). Duration is not calculated.

[c.] Source: Kovanen (2006). Duration is not calculated.

[d.] Source: Creamer and Rankin (2008). Duration is not calculated.

[e.] Source: Craigwell et al. (2011). The data present the range of price change frequencies on the 1 digit COICOP level. Posted prices only. The duration is calculated by $-1/(ln(1-Fj))$.

[f.] Source: Mahabir and Jagessar (2011). The data present the range of price change frequencies. Posted prices only.

[g.] Source: Ganga (2011). Posted prices only. The duration is calculated by $-1/(ln((1-Fj))$.

[h.] Source: Polius and St. Catherine (2011). Posted prices only. The duration is calculated by $-1/(ln(1-Fj))$.

One month is on average 30 days; 2.2 months is equal to 2 months and 6 days.

To set the maximum threshold value for sticky prices, the information of the countries reporting infrequent price change frequencies are used, specifically the United States and the countries in the euro area. Bils and Klenow (2004) registered an average posted price change frequency of 26.1% and reported that prices are both sticky and flexible in the United States. In the National Bureau of Economic Research (NBER) version of this publication (Bils & Klenow, 2002, p. 14), the sticky price sector was defined as representing 10th percentile of price change frequencies (or 10% of months), and the flexible prices represented the 90th percentile. The euro countries of Austria (Baumgartner et al., 2005, p. 5) and France (Baudry et al., 2004, p. 33) have been described as having "sticky" price changes. The respective mean price change frequencies were 15.0%, and 18.9%. Meanwhile, Dhyne et al. (2005) described the low speed of price adjustment in the euro area as "rarely" (p. 12) occurring price adjustments. In the euro area, the maximum mean posted price change frequency was 22%. As this is the maximum value reported for sticky prices, the upper bound threshold value of a mean price change frequency of 22% is used to define sticky prices in this dissertation.

To assess whether prices are sticky or flexible in Curaçao, the benchmark of 22% is applied to the mean price change frequency of this country. In addition, the stylized facts of the price adjustments provide information on price setting in Curaçao.

### 3.2. Stylized Facts on Price Adjustment in Curaçao

Following the IPN project of the Euro area, the CCMF initiated a study on price rigidity in the Caribbean area. The CCMF project started in 2008 and had a similar objective to the IPN project, namely to provide information on inflation persistence and price rigidity. The CCMF project produced data on price change frequency, increases and decreases, the duration of price spells, and the sizes of price changes in the Caribbean area (CCMF, 2011). From five Caribbean

countries that responded, only three were micro-islands, namely, Barbados, Saint Lucia, and Curaçao. The response rate corresponds to one-fifth of the total population of the Caribbean micro-islands.

From the three micro-islands, only the micro-data for Curaçao were available for my research.[22] This section presents (stylized facts of) the CPI micro-data for Curaçao in the period of October 2006–March 2010. The raw micro–price data were collected by the CBS of Curaçao for the purpose of constructing the CPIs. The monthly collected "on-the-shelf" price quotes included those items of household expenditures as reported in the budget surveys, which are administered every 5 years.

The categories of the CPI data excluded rental fees and covered 82% of the CPI. June 2009 was unreported, due to an error made by the statistical office when providing the data. The type of prices was posted prices. Data in the analysis on the price adjustments in Curaçao by Carolina (2011), published in the CCMF publication of 2011, were revised to include observed data only, thereby excluding the non-observed rental fees. The rental fees in the database were set by the CBS to rise automatically every month by 0.2% and were not monitored.

The CBS of Curaçao used its own classification system for product categories of the CPI. To increase the comparability with other studies in this field, the product categories were reclassified using the UN classification system, namely the classification of individual consumption according to purpose (COICOP). The COICOP contains three levels of aggregation of product categories. The first level is the two digit-code of the individual consumption expenditure of households. Category 01 consists of "food and non-alcoholic

[22] A comparative analysis between the Caribbean micro-islands on the stylized facts of price change frequency would have been useful; however, the micro-data of the respective countries were exclusively available to *national* researchers under strict confidentiality rules.

beverages" and Category 02 of "alcoholic beverages, tobacco and narcotics." The second level, representing the subcategories of the first level, has a three digit code (e.g., 01.1 for "food" or 02.2 for "tobacco"). The third level is the four digit code of the product item. For example, the codes of 01.1.2 and 09.5.1 refer to "meat" and "books," respectively.

The first and the second levels of the COICOP classification are used to present the data for Curaçao in Tables 3.5, 3.6, and 3.7. In Table 3.5, the data of the price change frequencies are presented, denoted in percentage of months. The third level of the COICOP also presents the possibility of partitioning and analyzing commodities in terms of the categories of durables (d), non-durables (nd), services (s), and semi-durables (sd). The classification by category at the first level is derived from the combination of the classifications used at the third and the second levels of the COICOP. In the second column, these combined types of commodities are presented.

Table 3.5

*Frequencies of Price Changes in Curaçao (in Percentage of Months, November 2006–March 2010)*

| COICOP | Type[a] | Expenditure category | Frequencies (in % of months) | | |
|---|---|---|---|---|---|
| | | | Price change [b] | Price increase | Price decrease |
| (1) | (2) | (3) | (4) | (5) | (6) |
| 01.1 | nd | Food | 15 | 10 | 5 |
| 02 | nd | Beverages & tobacco | 53 | 36 | 17 |
| 03 | nd/sd | Clothing & footwear | 4 | 3 | 1 |
| 04 | nd/s | Housing, water, electricity, gas, & other fuels | 4 | 3 | 1 |
| 05 | d/sd | Furnishing, household equipment, & routine household maintenance | 7 | 5 | 2 |
| 06 | d/nd/s | Health | 12 | 8 | 4 |
| 07 & 08 | d/sd/s | Transportation & communication | 9 | 7 | 2 |
| 09 & 10 | d/sd/s | Recreation & education | 5 | 3 | 2 |
| 12 | d/sd/s | Miscellaneous goods & services | 9 | 6 | 3 |

*Notes.*

[a.] Type categorizes the commodities by durables (d), non-durables (nd), services (s), and semi-durables (sd).

[b.] Column 4=Column 5+ Column 6.

The first stylized fact is that price change frequencies in the categories are heterogeneous. The frequencies of price changes vary from low in most categories to high in the category of "beverage and tobacco." Curaçao has a mean price change frequency of 9% of months. Since this is lower the benchmark of sticky prices of 22%, Curaçao has sticky prices. The second stylized fact is the low mean price change frequency of 9% and sticky prices in Curaçao. The third stylized fact is the asymmetric price-setting behavior. In all categories, prices are sticky downwards, as price increases occur more frequently than price decreases. Low frequencies of price change, as shown in Table 3.5, by definition correspond to high durations of price spell, which are listed in Table 3.6. Table 3.6 presents the mean and the median durations of price spell

in months. The price-flexibility hypothesis on micro-islands suggests short durations of price spells. However, the data show high mean and median durations of price spell of at least 4 months, with exception of the "beverages and tobacco" category. Hence, the fourth stylized fact is the long durations of price spells with exception of the beverages and tobacco. This category has a low duration of price spells, as these items are high-demand export products, and thus their prices change frequently.

Table 3.6

*Mean and Median Duration of Price Changes in Curaçao (in Months in the Period of November 2006–March 2010)*

| COICOP | Type [a] | Expenditure category | Duration | |
|---|---|---|---|---|
| | | | Mean[b] | Median[b] |
| (1) | (2) | (3) | (4) | (5) |
| 01.1 | nd | Food | 6.20 | 4.30 |
| 02 | nd | Beverages & tobacco | 1.30 | 0.90 |
| 03 | nd/sd | Clothing & footwear | 24.50 | 17.00 |
| 04 | nd/s | Housing, water, electricity, gas, & other fuels | 10.30 | 7.10 |
| 05 | d/sd | Furnishing, household equipment, & routine household maintenance | 13.80 | 9.60 |
| 06 | d/nd/s | Health | 7.80 | 5.40 |
| 07 & 08 | d/sd/s | Transportation & communication | 10.60 | 7.30 |
| 09 & 10 | d/sd/s | Recreation & education | 19.45 | 13.50 |
| 12 | d/sd/s | Miscellaneous goods & services | 10.60 | 7.45 |

*Notes.*

[a] Type categorizes the commodities by durables (d), non-durables (nd), services (s), and semi-durables (sd).

[b] Mean and median are calculated on the assumption of continuous price setting (in days or weeks).

While facts on the frequencies and durations of price spells provide information on the degree of flexibility of price adjustment, the sizes of price adjustments offer additional information on price setting. The sizes of the price changes are presented in Table 3.7. The fifth

stylized fact is that the sizes of price changes are almost symmetrical. The average size of price increases and decreases are almost symmetrical in the categories of "food," "beverages and tobacco," "housing, water, electricity, gas, and other fuels," and "health." The largest average price decline was reported in the category "clothing and footwear," and the largest average price increase occurred in the category of "housing, water, electricity, gas, and other fuels." Among other things, the latter consists of energy prices, which have the tendency to increase substantially in a period of oil price hikes.

Table 3.7

*The Average Size of Price Increases and Decreases in Curaçao (November 2006–March 2010)*

| COICOP | Type [a] | Expenditure category | Average size increase | Average size decrease |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| 01.1 | nd | Food | 12.3 | –12.3 |
| 02 | nd | Beverages & tobacco | 11.1 | –11.7 |
| 03 | nd/sd | Clothing & footwear | 18.0 | –23.0 |
| 04 | nd/s | Housing, water, electricity, gas, & other fuels | 21.0 | –20.9 |
| 05 | d/sd | Furnishing, household equipment, & routine household maintenance | 10.7 | –11.9 |
| 06 | d/nd/s | Health | 9.1 | – 8.1 |
| 07 & 08 | d/sd/s | Transportation & communication | 10.7 | –14.2 |
| 09 & 10 | d/sd/s | Recreation & education | 19.3 | –13.5 |
| 12 | d/sd/s | Miscellaneous goods & services | 10.5 | – 8.8 |

*Notes*.

[a] Type categorizes the commodities by durables (d), non-durables (nd), services (s), and semi-durables (sd).

### 3.3. Conclusions

The aim of this chapter was to provide an analysis of price adjustments, whether they are sticky or flexible in Curaçao. A commonly used yardstick of price change frequency that qualifies sticky prices has not yet been set in the existing literature. To arrive at a benchmark,

the literature on price adjustments based on the CPI was used. As low price change frequencies mark price stickiness, the benchmark for sticky prices applied in this chapter was a mean price change frequency lower than 22%. Since its mean price change frequency is 9%, Curaçao has sticky prices.

The stylized facts on frequency and the magnitude of price adjustments showed important aspects of the price adjustments in Curaçao. The price change frequencies were heterogeneous, with low and high price change frequencies in the different CPI categories. At 9%, the mean price change frequency was significantly low. This corresponded to an average duration of price spells of 10 months. Another stylized fact is that prices are sticky downward, meaning that prices were found to be resistant to drop.

As the distinction between short- and long- term is usually set at 1 year, the duration of price spells of 10 months could be classified as short-term. Therefore, prices in Curaçao are sticky in the short-run. This implies that the price-flexibility hypothesis fails to hold in Curaçao, creating a price-rigidity puzzle. This puzzle will be examined further in this dissertation, particularly in terms of the determinants of the price rigidity and which price-rigidity theories apply on a micro-island. One theory that is not applicable in Curaçao is the kinked demand theory. According to this theory, the oligopolist wants to increase the market share by price reductions; this is inconsistent with the sticky downward prices in Curaçao.

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# CHAPTER 4

# ON THE FREQUENCY AND SIZE OF PRICE CHANGES IN CURAÇAO

Cost shocks, such as higher (oil) import prices or increases in the transportation costs, are usually followed by domestic price adjustments. However, despite the frequent cost shocks, firms in Curaçao have changed prices infrequently; thus, the determinants of price change frequencies require further exploration. The intriguing question is as follows: What drives the price change frequencies in Curaçao?

The price-rigidity hypotheses that are likely to apply in Curaçao are tacit collusion and the state-dependent and time-dependent theories. In addition, the degree of market competition is discussed as a potential factor of influence on the frequencies of price change in Curaçao. The hypotheses of tacit collusion and the degree of market competition are both based on (characteristics of) market structures, which influence the price change frequencies. An oligopolistic market structure is one factor that has been found to influence price change frequencies. In the hypothesis of *tacit collusion*, each oligopolist will avoid lowering the price, even if the demand elasticity has changed. According to Stiglitz (1984), even when the demand curves of commodities change, firms will not adjust their prices because the losses incurred by not adjusting prices are outweighed by the gains from the collusive behavior. Hence, tacit collusion in the oligopolistic market may be an explanation for infrequent price changes.

Another factor considered to influence the price change frequencies is the degree of market competition (Carlton, 1989; Fabiani et al., 2005). The degree of market competition declines with lower numbers of sellers in a market. An inverse indicator often used to measure the degree of market competition is the Q4, which is the market share of the four largest companies. Markets

with higher competition are reported to have higher price change frequency. The studies of Carlton (1989) and Bils and Klenow (2004) showed an inverse relation between the concentration ratio values (measured using the Q4) and the frequency of price change. This is because markets with a high degree of competition often have elastic demand (Bils & Klenow, 2004).[23] Time series data on the market structures in Curaçao, such as the Q4, demand curves, and price change frequencies, are not available; thus, the hypotheses based on market structures will not be analyzed further.

The remaining price-rigidity hypotheses are the TDP and SDP theories. TDP was developed by Taylor (1980) and Calvo (1983). The Taylor TDP is defined as changing prices every *n*th period, while in the Calvo TDP, prices change at random.[24] SDP is when prices are determined by the state of the economy, for example, by inflation. The TDP and SDP hypotheses may explain the price change frequencies in Curaçao. The objective of this chapter is to explore the factors of time-dependent and state-dependent pricing that determine the frequency of price adjustments in Curaçao. In addition, as sizes of price adjustment and price change frequencies are jointly determined, the sizes of price adjustments are analyzed.

Sticky prices entail low price change frequencies. Thus, the variables that lower the price change frequency are an explanation for sticky prices. The price-rigidity theories that explain the price-rigidity puzzle in Curaçao are those with the variables that are inversely related to the price change frequencies.

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[23] This relationship between the degree of competition and demand elasticity is based on the monopolistic pricing of $p = mc/(1 - \frac{1}{\varepsilon})$, where $p$ is the price, $mc$ is the marginal cost, and ε is the demand elasticity. When $\varepsilon=\infty$, signifying an elastic demand, $p = mc$, a market of a perfect competition is implied (with free entry and exit of firms, the monopoly with elastic demand turns into perfect competition). When $\varepsilon<\infty$, representing less elastic demand, then $p > mc$, implying an imperfect competitive market.

[24] Both Taylor and Calvo TDPs may occur simultaneously in the commodity markets, as each commodity has its own pricing behavior in each time interval.

The sections in this chapter are partitioned as follows: After the literature overview on the determinants of price change frequency and sizes of price changes in Section 4.1, their definitions and the calculus are presented in Section 4.2. Panel models of price change frequencies and their sizes are presented in Section 4.3. Using the panel analysis, the relevancy of the selected price-rigidity theories of state- and time-dependent pricing are tested for the case of Curaçao in Section 4.4, and Section 4.5 identifies the theories of price rigidities that are consistent with the data.

## 4.1. Determinants of Price Change Frequencies and their Sizes

My analysis of the determinants and sizes of price change frequency in Curaçao is similar to the approach used in the studies by Dhyne et al. (2005), Klenow and Malin (2010), and Nakamura and Steinsson (2013). The main focus is on the explanatory variables of SDP and TDP that are likely to apply in Curaçao. The expected signs of the relation between the explanatory variable and the dependent variables are shown in Table 4.1. The dependent variables are the price change frequencies or the sizes of price changes. The term "positive" means that a positive correlation is expected between the dependent variable and the explanatory variable; otherwise, a "negative" relationship is expected. A question mark means that either sign can be expected. In addition, the expected sign for the test of price stickiness, which is based on the price change frequency, is shown (Table 4.1, Column 8).

### 4.1.1. State-dependent Variables and Price Change Frequencies

The state-dependent variables that influence the price change frequency are inflation and attractive pricing (Dhyne et al., 2005). High inflation is positively related to the frequency of price increase, and the frequency of price decrease is negatively related with inflation (Nakamura & Steinsson, 2008). There is no a priori assumption on the relation between the price change

frequency and inflation. In attractive pricing, firms are reluctant to change prices ending in 5 or 9 (Levy et al., 2011), and therefore, an inverse relationship is expected between all price change frequencies (price change frequency, price increase frequency, and price decrease frequency) and attractive pricing (Table 4.1, Columns 3–5).

### 4.1.2. The Time-dependent Variables and Price Change Frequencies

The time-dependent variables consist of seasonality, political interference resulting from price regulation, the political business cycle, and regulatory capture. Seasonality is when the frequencies of price adjustments are affected in a specific period of time during the year. Seasonality is classified under time-dependent pricing, as price changes occur at random in a month/season. An example of seasonality is found in the US data (Nakamura & Steinsson, 2008). Accordingly, the first quarter has a (disproportionately) higher price change frequency than the other quarters of the year. Hence, high price change frequencies (positive relation) are expected "in season" and low(er) price change frequencies (negatively related) are expected in the "out-of-season" period. Hence, depending on the season, the sign for price change frequencies is either positive or negative (Table 4.1, Columns 3–5).

The *price regulation* of commodities in Curaçao is based on incomes and anti-inflationary policies (P. B. No. 117, 1961, P. B. No. 76, 1965). The price regulation determines the price floor/ceiling by setting a mark-up to cost and/or a period (e.g., month, quarter) to adjust prices. The latter affects the price change frequency and the former influence the sizes of price changes. Price ceilings in Curaçao are applied for selected food products, medical care services and selected drugs, health insurance, transportation services, and energy prices. The price adjustment of most goods occurs upon arrival at the store, which is consistent with Calvo TDP.

Tariffs of medical care services are regulated to adjust annually, consistent with Taylor TDP. The energy prices are adjusted monthly, consistent with Taylor TDP.

A price floor is applied in the case of the minimum wage, as the minimum wages *can* be adjusted by indexation (P. B. No. 110, 1972), which is consistent with Calvo TDP. Price regulation is expected to be negatively related to all price change frequencies (Table 4.1, Columns 3–5).

The *political business cycle* in price setting is when policymakers intervene in price setting during pre-election periods to increase their chances of re-election. In the case of Curaçao, despite the international oil price increases, policymakers often kept the energy prices fixed in the pre-election periods. Hence, this variable is expected to be negatively related to the price change frequency and frequency of price increases. Conversely, but rarely, international energy price declines did occur in the pre-election periods. On these occasions, policymakers were keen on passing on the international energy price declines in the domestic energy prices. Hence, a positive relation is expected between the political business cycle and price frequency declines.

*Regulatory capture* is when, under pressure from interest groups, the regulatory authority agrees to keep prices fixed. The regulatory authority collaborated with the government in Curaçao in times of oil price hikes in 2006, and the energy prices were kept fixed. In this period, the incurred losses for keeping the energy prices fixed were financed through the "Energy Fund." Energy prices are a cost component in the production process of most goods and services. Keeping the energy prices fixed may have *indirectly* negatively affected the price change frequencies of (non-energy) commodities in Curaçao. The variables of the political business cycle and regulatory capture (Energy Fund) are combined into one variable in Table 4.1 for

efficiency reasons. First, both the political business cycle and regulatory capture (the Energy Fund) have similar effects on the price change frequencies. The combined variable shows one combined effect instead of two separate variables with similar effects. Second, these are both political interference variables expressed in periods of time; the business cycle is represented in the pre-election periods and the Energy Fund in the period of 2006–2007. Third, the period of regulatory capture was a one-year event, which is a relatively short period of time. A combination with the political business cycle periods is therefore preferable.

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Table 4.1

*The Determinants of Price Change Frequencies and their Sizes in Curaçao (a priori expected signs)*

| | | Dependent variable | | | | | |
|---|---|---|---|---|---|---|---|
| Models | Explanatory Variables | Frequency of price change | Frequency of price increase | Frequency of price decrease | Size of price increase | Size of price decrease | Test for sticky prices |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| State-dependent | -Inflation | ? | Positive | Negative | Positive | Negative | |
| | -Attractive pricing | Negative | Negative | Negative | ? | ? | Negative |
| Time-dependent | -Season | ? | ? | ? | ? | ? | Negative |
| | -Regulation | Negative | Negative | Negative | Negative | ? | Negative |

*Notes.*

A "negative" means a negative sign, hence an inverse relation, and a "positive" a positive sign, thus a positive relation. A "?" means that positive or negative signs are plausible.

### 4.1.3. State-dependent Pricing and the Size of Price Changes

The determinants of the *sizes* of price changes are similar to those of the price change frequencies, as the time of price adjustment and the size are jointly determined. In contrast to the frequency of price changes, the size of the price changes will not determine whether prices are sticky; however the determinants of the size will provide valuable information on price setting. After a shock, the price setter will decide whether to adjust the price fully/partially or leave it unchanged. Full or partial adjustment results in a change in size. Inflation, a state-dependent variable, also influences the *size* of price changes, or the *extensive* margin. High inflation increases the size of (positive) price change (Table 4.1, Column 6), and in contrast, high inflation is expected to have a negative impact on the size of price declines (Column 7). There is no a priori assumption on the relationship between the attractive SDP and the size of the price change. This is shown by the question marks in Table 4.1 in Columns 6 and 7.

### 4.1.4. Time-dependent Pricing and the Size of Price Changes

There is no a priori assumption on the relationship between seasonality or price regulation and the size of price changes. Hence, either negative or positive relationships may apply.

In times of pre-elections and the Energy Fund, the rising international crude oil prices were not passed through in the domestic energy prices, thereby lowering the frequency of domestic energy price changes. As the energy prices are a “cost” factor for other domestic commodities, a delayed effect in the adjustment of the cost of production of the (non-energy) commodities would be expected. Thus, the sizes of price increases of the (non-energy) commodities were probably lower. Therefore, a negative relationship is expected between the size of price increases in the periods of the political business cycle and Energy Fund (Column 6).

No a priori assumption about the relationship between the factors of the periods of the political business cycle and the Energy Fund and the size of price decreases is expected (Column 7).

To summarize, the SDP and TDP hypotheses are tested for Curaçao. The state-dependent variables of inflation and attractive pricing, the time-dependent variable of seasonality, the political interference variable of the pre-elections and Energy Fund periods, and price regulation are explanatory variables of the price change frequencies and the sizes of price changes in Curaçao. Although both the frequency and the size of the price changes offer information on price setting, price rigidity is only determined by frequencies of price changes.

### 4.2. Measuring the Frequency and Size of Price Adjustment

The calculations of the frequency of price changes and the durations of price spells found in the studies of Bils and Klenow (2004) and Nakamura and Steinsson (2008) have become the standard in this field of research. The standard calculus of the methodology applied in these studies is extensively described in Dhyne et al. (2005). I follow this methodology because it facilitates the comparison of my results on price adjustment with those of other countries.

For each product in category $j$ in store $i$ at time $t$ with price $P_{ijt}$, Dhyne et al. (2005) use the following binary variables to characterize the price-setting behavior:

A binary variable for observation of the price at time $t-1$ and $t$ in store $i$

$$x_{ijt} = \begin{cases} 1, P_{ijt} \text{ and } P_{ij,t-1} \text{ are observed} \\ 0, \ P_{ijt} \text{ exists but not } P_{ij,t-1} \end{cases}. \tag{4.1}$$

Hence, at time $t$ for category $j$ in store $i$, if both $P_{ijt}$ and $P_{ij,t-1}$ are observed, then $x_{ijt} = 1$; otherwise, $x_{ijt} = 0$.

A binary variable indicating a price change in $t$

$$y_{ijt} = \begin{cases} 1, \ P_{ijt} \neq P_{ij,t-1} \\ 0, \ \text{otherwise} \end{cases}. \tag{4.2}$$

A binary variable indicating a price increase in $t$ (the sub-index *I* stands for increase)

$$y_{Iijt} = \begin{cases} 1, & P_{ijt} > P_{ij,t-1} \\ 0, & \text{otherwise} \end{cases}. \quad (4.3)$$

A binary variable indicating a price decrease in $t$ (the sub-index *D* stands for decrease)

$$y_{Dijt} = \begin{cases} 1, & P_{ijt} < P_{ij,t-1} \\ 0, & \text{otherwise} \end{cases}. \quad (4.4)$$

For i = 1 to $n_j$, where $n_j$ represents the total number of stores in the product category *j* and $t \in [1, \tau]$, and $\tau$ is equal to the last observation period for the product category *j*, Dhyne et al. (2005) used these four binary variables to define the following four frequencies: the frequency of price changes, price increases, price decreases, and price changes for category *j* at time *t*. The *frequency of price changes* is expressed as follows:

$$F_j = \sum_{i}^{n_j} \sum_{t=2}^{\tau} y_{ijt} \,/\, \sum_{i}^{n_j} \sum_{t=2}^{\tau} x_{ijt}. \quad (4.5)$$

The *frequency of price increases* is expressed as follows (the sub-index *I* stands for increase):

$$F_j^{+} = \sum_{i}^{n_j} \sum_{t=2}^{\tau} y_{Iijt} \,/\, \sum_{i}^{n_j} \sum_{t=2}^{\tau} x_{ijt}. \quad (4.6)$$

The *frequency of price decreases* is expressed as follow (the sub-index *D* stands for decrease):

$$F_j^{-} = \sum_{i}^{n_j} \sum_{t=2}^{\tau} y_{Dijt} \,/\, \sum_{i}^{n_j} \sum_{t=2}^{\tau} x_{ijt}. \quad (4.7)$$

The *frequency of price changes at time $t$ for product category $j$* is expressed as follows:

$$F_{jt} = \sum_{i}^{n_j} y_{ijt} / \sum_{i}^{nj} x_{ijt}. \quad (4.8)$$

For the frequencies of price adjustments, no specific distribution is assumed. The information on the distribution of the price adjustment is obtained ex post with the statistics of the mean and the median. Price adjustments are defined as symmetrical when for each category *j*, the price frequency increases equal the price frequency decreases. Otherwise, the price frequencies are asymmetrical.

Dhyne et al. (2005) used the following calculations to define the average sizes of price adjustment and the duration of price spells:[25]

The *average size of price increases* in percentage

$$\overline{\Delta_j^{+}} = \sum_{i}^{n_j} \sum_{t=2}^{\tau} y_{I\,ijt} \,(ln\, P_{ijt} - ln\, P_{ij,t-1}) \,/\, \sum_{i}^{n_j} \sum_{t=2}^{\tau} y_{I\,ijt}\,. \quad (4.9)$$

[25] A price spell is defined as the period between two price changes. See Appendix 4A for more information.

The *average size of price decreases* in percentage

$$\overline{\Delta_J^-} = \sum_i^{n_j} \sum_{t=2}^{\tau} y_{D\ ijt} \left( ln\ P_{ij,t-1} - lnP_{ijt} \right) / \sum_i^{n_j} \sum_{t=2}^{\tau} y_{D\ ijt}\ . \quad (4.10)$$

To measure the duration of price spells, two methods are used depending on the assumption of the time variable, namely a discrete time or a continuous time approach. When prices are set in a time discrete manner, price change occurs only once per month and frequencies are expressed in number of months. The *average duration of a price spell* is the inverse of the frequency of the price change, expressed as follows:

$$T_j = 1/F_j. \quad (4.11)$$

Assuming a discrete time, Equation (4.11) is expressed in number of months. When it is assumed that prices are set in a continuous manner, which implies that a price can change at any point during the month, the average price duration of the product category *j* is calculated as follows:

$$\overline{T_J} = -1 / ln\ (1 - F_j\ ). \quad (4.12)$$

Hence, Equation (4.12) can be expressed in (a combination of) days, weeks, or months. For example, suppose that there are 60 products for which 30 price changes have been reported. Thus, $F_j$ =0.50, meaning that price changes occur in 50% of months. When the duration is calculated in a discrete manner, a price change of a product only occurs once a month, and $F_j$ =0.50, 15 products (of the 30) can change their prices the first month and the other 15 can change theirs in the second month. Hence, it takes 2 months on average for prices to change. For the duration of price spells using Equation (4.11), $T_j = 2$ months. A duration in a continuous manner implies that a price change per product can occur often during the month, and the duration can be denoted in weeks or days. This results in a reduction in the time spells compared to discrete time spells. Using the same example of 60 products where 30 change their prices, and

assuming that every day, there is one price change and that a month has 30 days,[26] 30 products change their prices in 1 month. Thus, the duration is approximately 1 month. Using Equation (4.12), $\overline{T_J} = 1{,}44$ months, equal to 1 month and 13 days, which is a reduction of 17 days in the price spell when compared to the discrete approach.

The *median price duration* (in a continuous time frame) is calculated as follows:

$$T_j = ln(0.5) \,/\, ln\,(1 - F_j\,). \tag{4.13}$$

Equation (4.13) can be expressed in (a combination of) hours, days, weeks, months, or years. The statistics commonly used in the literature on price adjustment are the mean and median of the price change frequencies, the price frequency increases and decreases, the mean sizes of price increases and decreases, and the mean and median of the durations of price spells. The standard deviations of the frequencies are usually not reported, as the sample size of each category is large in comparison to the deviations, which are expressed in fractions. This means that the standard deviations are negligibly small. An example of the relatively large sample of micro-data databases is shown in Table 4A in Appendix 4A for the case of Curaçao.

### 4.3. The Panel Data and Analysis

The panel analysis explores the determinants of the frequency and size of the price change. The determinants are the variables of SDP and TDP (including political interference). Inflation and attractive pricing are state-dependent variables, while the seasonality, political interference variables in periods of the pre-election, Energy Fund, and price-regulated goods are time-dependent variables. The sample period covers November 2006−March 2010 and excludes the month of June 2009. This omission represents an error of the statistical office at the time of the data delivery. The panel data (excluding rental fees) are classified into two databases, as

[26] In practice, working days are applied; a regular month has 20 working days.

follows: Panel I uses the CPI product categories (e.g., food, housing), while in Panel II, the commodities are classified by type (e.g., durables, non-durables). The panel data also exclude the categories of energy prices, health insurance, and postal service tariffs because these data are indices. Thus, they are not suitable for calculating size (see Equation 4.10), nor is it possible to distinguish attractive prices with index data. To categorize attractive prices the last two digits of the price are needed, and indices are therefore, not useful.

### 4.3.1. Panel I Data: Product Categories

The panel data consist of time series for each of the nine following CPI categories: "food," "beverages and tobacco," "clothing and footwear," "housing," "furnishing, household equipment, and routine household maintenance," "health," "transportation and communication," "recreation and education," and "miscellaneous goods and services." Each category consists of data on the frequencies of price changes, price increases, price declines, and the average sizes of price increases and decreases. Added to the database are the data on inflation and attractive pricing (state-dependent variables), seasonality, time-dependent variable of the share of regulated goods, and the dummies of political pre-election and the Energy Fund.

### 4.3.2. Panel II Data: Commodities by Type

The classification by type of commodities is an alternative to the CPI product classification. There are five categories of commodities, as follows: non-durables (nd), non-durables and semi-durables (nd/sd), non-durables and services (nd/s), durables and semi-durables (d/sd), and the combination of all types except semi-durables (d/nd/s). Similar to Panel I, inflation, attractive pricing, dummies of seasonality, the price regulation variable, and the dummies for the pre-election and Energy Fund periods are added to the price change frequencies and their sizes in Panel II.

**The inflation data.** To calculate inflation, the Curaçao CPI data are retrieved from the IFS of the IMF, country code number 354. Figure 4.1 shows the month-to-month inflation rate, defined by $\pi_t = \ln\left(\frac{\mathrm{CPI_t}}{\mathrm{CPI_{t-1}}}\right) * 100$. The month-to-month inflation rate, $\pi_t$, was low, with an average of 0.24% in the period of November 2006−March 2010.

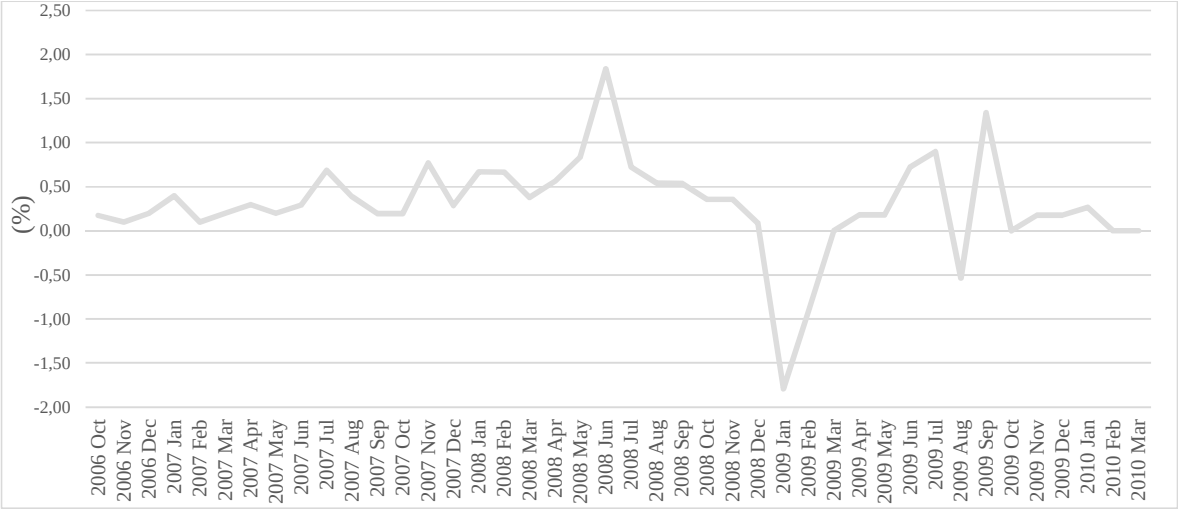


*Figure 4.1.* The monthly inflation rates in Curaçao (in percent, 2006.11–2010.03)

Source: IFS. Retrieved August, 28, 2013.

**Attractive pricing data.** Attractive pricing (or price points) is when prices have endings of 5, 9, or 99. In this study, these different attractive price endings were combined into one variable calculated by the total monthly prices ending in 5 and 9 (99 is a special case of the 9 endings) as a fraction of the total monthly observations.

**The seasonality dummy.** The seasonality variable is created by making dummies for each month separately. To avoid the "dummy variable trap" (Greene, 1997, p. 381), the month of October was chosen as the month of reference.

**The price regulation variable.** This variable is one of the political interference variables. The regulated commodities are listed in Appendix 4B (Table 4B). The categories of "food" and "health" are the most regulated. For each regulated commodity, a dummy variable,

regulated=1, is assigned. The variable of the price regulation per category is equal to the share of the total regulated commodities by category in the total of observed commodities per category.

**The dummy of pre-election and the Energy Fund.** Both of these dummies are political interference variables. The dummies of periods of the pre-elections and the Energy Fund are combined in one dummy. The pre-election dummy variable assigns a "1" in the pre-election periods and a "0" otherwise. The pre-election period is defined by 6 months prior to the election (Schuknecht, 1996). Table 4.2 shows the data for the pre-election dummy.

Table 4.2

*Dummy for the Pre-election Periods in Curaçao in 2006–2010*

| Elections by level of government | Election date | Dummy=1 for the months of: |
|---|---|---|
| Central Government | 17-Jan-06 | August 2005−January 2006 |
| Curaçao Government | 21-Apr-07 | November 2006−April 2007 |
| Central Government | 22-Jan-10 | August 2009−January 2010 |

*Note.* Source: Hoofdstem Bureau Curaçao (n.d.)

The Energy Fund was introduced in the period of the oil price hikes in 2006, following the pressure of interest groups to stabilize the energy prices. From June 2006 to July 2007, the energy prices remained fixed and were financed by the Energy Fund. The dummy variable of the Energy Fund is "1" for the months June 2006 to July 2007 and "0" otherwise. The dummy of the pre-election and the Energy Fund periods is the combination of these two periods and consists of "1" for the periods of the pre-election or the "Energy Fund" and "0" otherwise.

### 4.3.3. The Classical Fixed-Effects Models

The panel analysis was estimated by assuming fixed or random effects. A fixed-effects (FE) panel analysis was preferred over random effects (RE), as the FE framework assumes that

there are differences across the categories; this is consistent with the stylized fact of heterogeneity in price setting discussed in Chapter 3. The classical FE model, also termed the unobserved effects model (Wooldrigde, 2002), is described below.

Let $F_j$ be the T observations of the dependent variable for category *j*; the time constant term $\alpha_j$ is the unobserved variable or the individual effect for the cross-section *j*. $X_j$ is the T observations of K regressors (excluding the constant term) for category *j*, and $\epsilon_j$ is the Tx1 vector of disturbances or the idiosyncratic errors:

$$F_j = \alpha_j + X_j\beta + \epsilon_j. \tag{4.14}$$

This FE model, with the time constant term $\alpha_j$, is category specific (vary across category *j*) and given in matrix form, as follows (Greene, 1997, Section 14.3):

$$\mathrm{F} = D\alpha + X\beta + \epsilon, \tag{4.15}$$

where D is a matrix with dummies, $d_j$. Moreover, $d_j$ is a dummy variable indicating the *j*th category. Thus, D=[$d_1$ ... $d_n$].

According to Greene (1997), the $\hat{\beta}_{FE}$ (the estimator of the FE coefficient) is estimated with using ordinary least squares (OLS). Moreover, b, the matrix form of estimate of $\beta_{FE}$, is as follows:

$$\mathrm{b} = (X'M_dX)^{-1}\,(X'M_dF), \tag{4.16}$$

where

$$M_d = \mathrm{I} - \mathrm{D}(D'D)^{-1}D'. \tag{4.17}$$

To test whether the $\alpha_j's$ are equal to zero (in the case of no FE), the F-test is used.

### 4.3.4. The Fraction Fixed-Effects Models

For the model of the price change frequencies, the analysis of "proportions" data or "fraction" data is applicable, as the dependent variable, $F_j$, is a fraction. In the analysis of the

fraction data, $F_j$ is an estimate of the population frequency of category $j$. These proportions ($F_j$) are nonnegative values bounded by 0 and 1. A common method is the log-odds transformation of $F_j$ (Greene, 1997). For the $j$=1,…,9 categories in Panel I, or for $j$=nd, sd, nd/s, d/sd, d/nd/s in Panel II, the log-odds transformation is as follows:

$$\ln\left(\frac{F_j}{1-F_j}\right) = \beta' x_j. \tag{4.18}$$

$\hat{\beta}$ is estimated using OLS (Wooldridge, 2001). The coefficient of $\hat{\beta}$ is not equal to the elasticity.[27] More important than the interpretation of the coefficient are the signs and levels of significance of the coefficients in this analysis. The sign indicates whether the explanatory variable has a positive or negative relationship with the price adjustment frequency or size. The level of significance indicates whether the coefficients are significant.

A second method of estimating fractions is the quasi-maximum likelihood estimator (QMLE; Wooldridge, 2002). This is as follows:

$$\text{E}\left(\left(F_j \middle| x_j\right)\right) = \exp\left(\beta' x_j\right)/\left(1 + \exp\left(\beta' x_j\right)\right), \tag{4.19}$$

and the log likelihood is $l(\beta) = F_j \log(\text{G}(\beta' x_j)) + (1 - F_j)\log(1 - G(\beta' x_j))$, (4.20)

where G(.) is the logistic cumulative density function (cdf )function. The estimator is the QMLE, which maximizes the log likelihood; $\hat{\beta}$ is the logit estimator. I used the most common method to estimate the variable, which is the log-odds transformation with the OLS estimator. The program Eviews, version 7, was used to estimate the models.

### 4.3.5. Test of Price Stickiness

The test of price stickiness is a test of the price change frequency. As a low price change frequency is an indication of price stickiness, the test of price stickiness is a test on a negative,

[27] The elasticity (one unit increase in the variable $x_j$) is determined by the *exponential function* of $\beta$.

significant coefficient between the price change frequency variable and the state- or time-dependent variable. Attractive pricing, seasonality, regulation, and other political interference variables of political business cycle and the Energy Fund were tested for price stickiness. This test was not used to distinguish which theory provides the stickier prices, as it only shows whether a variable leads to sticky prices. The test shows a case of price stickiness when the explanatory variable is negatively correlated with the price change frequency (Column 8 of Table 4.1).

### 4.4. Empirical Results

The results using Panel I data with the CPI categories are shown in Tables 4.3 and 4.4, and the results for the categories by commodity type (Panel II data) are shown in Tables 4.5 and 4.6. Both panels exclude the data on the energy prices, insurance, rental fees, and postal services. Tables 4.3 and 4.5 show the FE equations with the dependent variables of price adjustment frequency (Column 2), price frequency increases (Column 3), and price frequency decreases (Column 4). These equations are estimated by applying the log-odds transformation of Equation (4.18) on the dependent variable. Tables 4.4 and 4.6 show the FE equations with the dependent variables of size increases (Column 2) and size decreases (Column 3). All equations are estimated using least squares. Both panels offer valuable information on the determinants of price change frequencies, the sizes of price changes, and the test of price rigidity.

The results show low $R^2$ ($0.38 < R^2 < 0.50$) and low adjusted $R^2$ ($0.31 <$adj. $R^2 < 0.48$) in the equations of price change frequencies and high $R^2$ ($0.74 < R^2 < 0.85$) and high adjusted $R^2$ ($0.74 <$adj. $R^2 < 0.84$) in the equations of sizes of price changes. The variables did not always have the expected signs. The variables with the incorrect signs are as follows: inflation in the size of price decrease equations in both panels and the attractive pricing in the equation of price

frequency increase in both panels. The following variables were insignificant, namely the explanatory variables of the size of price decreases in both panels. Meanwhile, some were significant in one panel and insignificant in the other. The dummy of political interference in periods of pre-election and the Energy Fund is significant in the price change frequency equation in Panel II, while it is rejected in the same equation in Panel I. Other variables were insignificant in the price change frequencies equations and significant in the size equations. Price regulation was not a significant explanatory variable in the equations related to the price change frequencies. However, price regulation was significant in the equations related to the sizes of price increases in both panels.

The FE are shown by the *F* statistics. The FE was rejected in the equations of size of the price decrease in Panel I, as well as the price frequency decrease, the size of the price decrease, and the frequency of price change in Panel II. Hence, in these equations, the constant terms (the sector-specific dummies) $\alpha_j's$ are equal to zero.

### 4.4.1. Panel I

The results for Panel I revealed that inflation had no impact on the price change frequencies. There was no evidence of a significant *positive* relation between inflation and the frequency of price *increases* or a significant *negative* relation between inflation and the frequency of price *decreases*. This is probably due to low inflation in Curaçao in the period under review. In addition, no support was found for the relation between price change frequency and attractive pricing. A significant negative relation between the price change frequency and attractive pricing was rejected. Hence, SDP is not consistent with the data for Curaçao in the period of 2006–2010.

TDP was tested in terms of seasonality and political interference. The results show a lower frequency of price increases for January in the category of "clothing and footwear" at a 10% significance level. The price change frequency was negatively affected in February at a 10% significance level. The lower price frequency was probably related to the lower price frequency *increases* in February (significant at 5%). The months of January and February are usually characterized by less sales after the peak of sales in the Christmas holidays.

The relationship between price change frequency and the variables of the political interference in the periods of pre-elections and Energy Fund were rejected. For regulations, the interaction between regulations and the category of "food" was chosen, as a large share of food was regulated. A significant relation between the price regulation in "food" and the price change frequency was not supported.

The relationship between the sizes of the price changes and the SDP and the TDP variables were also tested. Similar to the price change frequencies, state-dependent variables did not have an effect on the size of price changes. TDP of seasonality showed no significant relationship with the sizes of the price changes. Meanwhile, TDP by political interference was negatively related with the size of the price increase. The sizes of price increases were negatively affected by price regulation in the category of "food," at a 1% significance level, and in the periods of the pre-election and Energy Fund at a 5% significance level.

The category-specific constant terms ($\alpha_j$) were all significant at the 1% significance level with the exception of the "food" category in the equation of the price increase frequency. The *F* statistics allowed the hypothesis that the $\alpha_j's$ are equal to zero to be rejected. This finding is consistent with the heterogeneity across categories. In the size increase equation, the

heterogeneity across categories is shown, and the sector-specific categories were significant (at 1, 5, and 10%). In contrast, the sector-specific terms in the size declines were insignificant.

To summarize, when using Panel I, both SDP of attractive pricing and TDP of price regulation for the pre-election and the Energy Fund periods were rejected. The test on price rigidity was rejected for the attractive price hypothesis and the variables of political interference, namely price regulation and the periods of pre-elections and the Energy Fund. Meanwhile, the test on price rigidity supported the time-dependent variable of seasonality in February and in January for the category "clothing and footwear." In addition, the sizes of the price increases were negatively affected by the price regulation of the category "food" in the periods of the pre-election and the Energy Fund. This probably means that in these periods, the price increases were postponed or were reduced.

Table 4.3

*Price Change Frequencies in Curaçao*
*Panel I: Log Odds Regression of a Sample (Excluding Energy, Postal Services, Rental Fees, Insurance in November 2006–March 2010, OLS)*

| Variable | Price change frequency Panel fixed effects | Price increase frequency Panel fixed effects | Price decrease frequency Panel fixed effects |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| Inflation | 0.009<br>(0.08) | 0.04<br>(0.08) | –0.04<br>(0.07) |
| Attractive pricing (5 and 9 endings) | –0.13<br>(1.22) | 0.52<br>(1.23) | –0.59<br>(1.10) |
| Month of January*clothing & footwear-dummy | –0.35<br>(0.41) | –0.69*<br>(0.41) | –0.08<br>(0.35) |
| Month of February | –0.24*<br>(0.14) | –0.29**<br>(0.14) | –0.09<br>(0.13) |
| Regulation*food dummy | –10.32<br>(17.30) | –16.31<br>(17.34) | –7.72<br>(15.14) |
| Dummy pre-election and Energy Fund periods | –0.11<br>(0.09) | –0.14<br>(0.10) | –0.05<br>(0.09) |
| Food dummy | 1.25<br>(5.3) | 2.46<br>(5.28) | –4.97<br>(4.561) |
| Beverage and tobacco dummy | –2.16***<br>(0.78) | –2.99***<br>(0.78) | –3.18***<br>(0.71) |
| Clothing and footwear dummy | –3.22***<br>(0.87) | –4.14***<br>(0.87) | –3.92***<br>(0.78) |

Table 4.3

*Price Change Frequencies in Curaçao*
*Panel I: Log Odds Regression of a Sample (Excluding Energy, Postal Services, Rental Fees, Insurance in November 2006–March 2010, OLS)*

| | | | |
|---|---|---|---|
| Housing (excluding energy prices) dummy | –3.54***<br>(1.09) | –4.32***<br>(1. 09) | –4.16***<br>(0.998) |
| Furnishing, household, and household maintenance dummy | –2.51***<br>(0.76) | –3.37***<br>(0.76) | –3.44***<br>(0.69) |
| Health dummy | –1.98***<br>(0.50) | –2.80***<br>(0.50) | –2.97***<br>(0.45) |
| Transportation and communication dummy | –2.76***<br>(0.50) | –3.14***<br>(0.50) | –3.58***<br>(0.45) |
| Recreation and education dummy | –3.28***<br>(0.83) | –4.11***<br>(0.84) | –3.90***<br>(0.75) |
| Miscellaneous goods and services dummy | –2.29***<br>(0.80) | –3.10***<br>(0.80) | –3.35***<br>(0.72) |
| Number of observations panel | 337 | 329 | 311 |
| *R* squared | 0.41 | 0.38 | 0.38 |
| Adjusted *R* squared | 0.38 | 0.35 | 0.31 |
| Durbin–Watson | 2.26 | 2.07 | 2.26 |
| *F* statistics for fixed effects (*p*-value) | 0.00 | 0.00 | 0.00 |

*Notes*.

***,**,* indicate significant at 1%, 5% and 10%, respectively. Standard errors are between brackets. Each dummy represents the category-specific constant ($\alpha_j$). Eviews automatically adds a constant to the model specification to ensure that $\sum_{j=1}^{9} \hat{\alpha}_j$=0. Hence, $\sum_{j=1}^{9} \hat{\alpha}_j$ /9=constant term. All data which were indices were excluded from the panel data, as the calculation of attractive pricing was not feasible

*F* statistics on the significance of the dummies

Table 4.4

*Sizes of Price Increases and Decreases in Curaçao*
*Panel I: Least Squares Regression of a Sample (Excluding Energy, Postal Services, Rental Fees, and Insurance November 2006–March 2010)*

| Variables | Size increases Panel fixed effects | Size decreases Panel fixed effects |
|---|---|---|
| (1) | (2) | (3) |
| Inflation | 0.39<br>(0.27) | 0.09<br>(0.20) |
| Attractive pricing (5 and 9 endings) | –6.38<br>(4.21) | 3.59<br>(3.23) |
| Month of January*clothing and footwear dummy | –0.42<br>(1.41) | 0.77<br>(1.05) |
| Month of February | –0.34<br>(0.49) | –0.27<br>(0.38) |
| Regulation*food dummy | –358.13***<br>(56.59) | –62.02<br>(44.34) |
| Dummy of pre-election and Energy Fund periods | –0.93**<br>(0.34) | 0.22<br>(0.25) |
| Food dummy | 131.68***<br>(18.14) | 5.56<br>(13.49) |
| Beverage and tobacco dummy | 6.10**<br>(2.69) | –3.12<br>(2.07) |
| Clothing and footwear dummy | 5.40*<br>(2.99) | –3.55<br>(2.29) |
| Housing (excluding energy prices) dummy | 7.42**<br>(3.764) | –3.72<br>(2.87) |
| Furnishing, household, and household maintenance dummy | 6.029**<br>(2.62) | –3.17<br>(2.01) |

Table 4.4

*Sizes of Price Increases and Decreases in Curaçao*
*Panel I: Least Squares Regression of a Sample (Excluding Energy, Postal Services, Rental Fees, and Insurance November 2006–March 2010)*

| | | |
|---|---|---|
| Health dummy | 3.08*<br>(1.70) | –1.70<br>(1.31) |
| Transportation and communication dummy | 3.62**<br>(1.72) | –1.91<br>(1.32) |
| Recreation and education dummy | 5.37*<br>(2.87) | –3.23<br>(2.21) |
| Miscellaneous goods and services dummy | 5.59**<br>(2.75) | –2.87<br>(2.11) |
| Number of observations panel | 329 | 311 |
| *R* squared | 0.85 | 0.77 |
| Adjusted *R* squared | 0.84 | 0.76 |
| Durbin–Watson | 1.92 | 1.50 |
| *F* statistics for fixed effects (*p*-value) | 0.00 | 0.75 |

*Notes.*

***,**,* indicate significant at 1%, 5% and 10%, respectively. Standard errors are between brackets. Each dummy represents the category-specific constant ($\alpha_j$ )
Eviews automatically adds a constant to the model specification to ensure that $\sum_{j=1}^{9} \hat{\alpha}_j = 0$. Hence, $\frac{\sum_{j=1}^{9} \hat{\alpha}_j}{9} =$ constant term.
*F* statistics on the significance of the dummies

### 4.4.2. Panel II

The results for inflation, attractive prices, and price regulation were not significant; thus, the hypotheses were rejected in the alternative classification by type of commodities in Panel II. The variables of the political interference in the periods of pre-elections and the Energy Fund were supported in Panel II for the categories of non-durables and semi-durables. The variables of political interference did not support an increase in frequencies of price declines in the periods of pre-elections and the Energy Fund. The size of the price increase was positively related with inflation at a 10% significance level. Price regulation and the variables of political interference in the periods of pre-elections and the Energy Fund were negatively related with the size increases and significant at 1% and 5%, respectively.

The tests of price rigidity on state-dependent variables were rejected when using the data for Panel II. The relationship between the time-dependent variable of price regulation was also not significant. However, in contrast to Panel I, the hypothesis on the political interference in the periods of pre-election and the Energy Fund was not rejected. The interaction of political interference in the periods of pre-election and the Energy Fund for the categories of non-durables and semi-durables (including the items of food, beverages, clothing, and housing) showed price rigidity at the 5% level; this was probably related to the lower frequency of price increases (at the 10% significance level). This relationship shows the delayed pass through of the energy prices, and therefore, unadjusted costs in the prices of non-energy commodities. Hence, in Panel II, SDP was rejected, while TDP was supported in relation to political interference in the periods of pre-election and the Energy Fund in the categories of non-durables and semi-durables. In addition, the *F* statistics of sector-specific coefficients of the price change frequency and size of price increase were significant and consistent with heterogeneity in pricing.

To summarize, Panels I and II showed the various characteristics of the price adjustments. The results of the two panels demonstrated that the classification is important, as each panel illustrated different determinants to explain the frequencies of price adjustment. Price rigidity due to seasonality was disclosed when the commodities were classified using the CPI categories (Panel I), while price rigidity due to political interference in periods of pre-elections and the Energy Fund were observed in the "non-durables" and "semi-durables" categories (Panel II). The price regulation affected only the size of the price increases. FE were found in the equations of price change frequencies and the size of price increase in Panel I. For Panel II, FE were found in the equations of frequency of price increase and the size increase.

Table 4.5

*Price Change Frequencies in Curaçao by Type of Commodities*
*Panel II: Log Odds Regression of A Sample (Excluding Energy, Postal Services, Rental Fees, Insurances in November 2006–March 2010, OLS)*

| Variable | Price change frequency Panel fixed effects | Price increase frequency Panel fixed effects | Price decrease frequency Panel fixed effects |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| Inflation | 0.03<br>(0.09) | 0.11<br>(0.10) | 0.00<br>(0.08) |
| Attractive pricing (5 and 9 endings) | –0.67<br>(1.43) | 0.41<br>(1.49) | –0.57<br>(1.19) |
| Regulation | –5.87<br>(15.28) | –14.31<br>(15.91) | 17.90<br>(12.62) |
| Dummy for pre-election and Energy Fund periods*category (nd/sd) | –0.52**<br>(0.26) | –0.47*<br>(0.27) | –0.17<br>(0.22) |
| Non-durables dummy (nd) | 0.06<br>(4.03) | 1.12<br>(4.21) | –7.33**<br>(3.34) |
| Non-durables and semi-durables dummy (nd/sd) | –2.77***<br>(1.02) | –4.08***<br>(1.06) | –3.91***<br>(0.85) |
| Non-durables and services dummy (nd/s) | –3.14**<br>(1.27) | –4.33***<br>(1.32) | –4.21***<br>(1.06) |
| Durables and semi-durables dummy (d/sd) | –2.20**<br>(0.89) | –3.32***<br>(0.93) | –3.52***<br>(0.74) |
| Durables/non-durables and services dummy (d/sd/s) | –2.14**<br>(0.87) | –3.15***<br>(0.90) | –3.63***<br>(0.72) |
| Number of observations panel | 180 | 176 | 172 |
| *R* squared | 0.50 | 0.45 | 0.50 |
| Adjusted *R* squared | 0.48 | 0.42 | 0.48 |
| Durbin–Watson | 1.92 | 1.63 | 2.1 |
| *F* statistics for fixed effects (*p*-value) | 0.12 | 0.02 | 0.15 |

*Notes.*

***,**,* indicate significant at 1%, 5% and 10%, respectively. Standard errors are between brackets. Each dummy represents the category-specific constant ($\alpha_j$). Eviews automatically adds a constant to the model specification to ensure that $\sum_{j=1}^{5} \hat{\alpha}_j = 0$. Hence, $\frac{\sum_{j=1}^{5} \hat{\alpha}_j}{5} =$ constant term. All data which were indices were excluded from the panel data, as the calculation of attractive pricing was not feasible.

*F* statistics on the significance of the dummies.

Table 4.6

*Sizes of Price Increases and Decreases in Curaçao*
*Panel II: Least Squares Regression of a Sample (Excluding Energy, Postal Services Rental Fees, and Insurance in November 2006–March 2010)*

| Variable | Size increases Panel fixed effects | Size decrease Panel fixed effects |
|---|---|---|
| (1) | (2) | (3) |
| Inflation | 0.96*<br>(0.53) | 0.15<br>(0.37) |
| Attractive pricing (5 and 9 endings) | –10.09<br>(7.87) | 6.05<br>(5.71) |
| Regulation | –239.33***<br>(87.77) | –89.74<br>(60.57) |
| Dummy for pre-election and Energy Fund periods | –1.47**<br>(0.71) | 1.17<br>(1.07) |
| Non-durables dummy (nd) | 89.18***<br>(22.93) | 7.59<br>(16.01) |
| Non-durables and semi-durables dummy (ns/sd) | 8.04<br>(5.55) | –5.49<br>(4.07) |
| Non-durables and services dummy (nd/s) | 10.74<br>(6.99) | -5.90<br>(5.08) |
| Durables and semi-durables-dummy (d/sd) | 8.96**<br>(4.89) | –4.57<br>(3.54) |
| Durables/non-durables and services dummy (d/sd/s) | 11.62**<br>(4.76) | –4.51<br>(3.45) |
| Number of observations panel | 176 | 172 |
| *R* squared | 0.83 | 0.74 |
| Adjusted *R* squared | 0.82 | 0.74 |
| Durbin–Watson | 1.85 | 1.49 |
| *F* statistics for fixed effects (*p*-value) | 0.00 | 0.79 |

*Notes.*
***,**,* indicate significant at 1%, 5% and 10%, respectively. Standard errors are between brackets. Each dummy represents the category-specific constant ($\alpha_j$). Eviews automatically adds a constant to the model specification to ensure that $\sum_{j=1}^{5} \hat{\alpha}_j = 0$. Hence, $\frac{\sum_{j=1}^{5} \hat{\alpha}_j}{5} =$ constant term. All data which were indices were excluded from the panel data, as the calculation of attractive pricing was not feasible.
*F* statistics on the significance of the dummies.

Table 4.7 presents the results on the test of sticky prices. The SDP hypotheses were rejected as determinants of sticky prices, while most of the selected TDP hypotheses were supported. On the balance, most of the SDP and TDP hypotheses were rejected. The reason for the rejection of the majority of the hypotheses was that, with the exception of the hypothesis of political interference, they were formulated for developed countries. Although these selected hypotheses were expected to apply to a micro-island, the tests proved otherwise. The rejection of price regulation, a variable representing political interference, was due to the sample of commodities, which consisted of non-energy commodities. Energy commodities represented the largest group of commodities that were regulated by a contract period wherein prices were fixed. Hence, the exclusion of the energy prices from the sample resulted in a rejection of this hypothesis.

The TDP of seasonality, political interference of the political business cycle, and the regulatory capture by the Energy Fund in the categories of non-durables and semi-durables (Panel II) were supported by the data, whereas the TDP of price regulation and SDP were rejected. Hence, the sticky prices were explained by seasonality and in the categories of non- and semi-durables in periods of the political business cycle and the Energy Fund. In particular, the results showed that in the case of price-rigidity hypothesis of the political business cycle and the Energy Fund, the classification of the data (in panels) mattered. This is most probably related to the indirect effect of the sticky energy prices for a broad variety of non-energy commodities. This variety is probably easier to capture via “broader” classification by type (non-/semi-durables) categories. Both classification systems of the data, by type and by product category, proved valuable in deriving the relevant price-rigidity theories.

Table 4.7

*The Summary of the Results of the Sticky Price Test (Excluding Energy, Postal Services, Insurances in November 2006–March 2010)*

| Models | Explanatory Variables: | Panel I Test for sticky prices | Panel II Test for sticky prices |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| State-dependent | -Inflation | Rejected | Rejected |
| | -Attractive pricing | Rejected | Rejected |
| Time-dependent | -Season | Supported | Not tested |
| | -Regulation | Rejected | Rejected |
| | -Political business cycle (pre-election) and the Energy Fund | Rejected | Supported |

The impact of the price regulation is particularly noticeable in the sizes of the price changes. The price regulation in the selected CPI-categories led to lower price increases. Table 4.8 presents a summary of the impact of the SDP and the TDP hypotheses on the sizes of price increases. The expected signs for the size of price decreases were rejected for the SDP and TDP hypotheses, hence only the results of the price increases are presented. Consistent with the expectations, higher inflation resulted in higher size of price increases (in Panel II), and in both panels the price regulation, and the periods of the political business cycle and the "Energy Fund" led to reduced sizes of the price increases.

Table 4.8

*Summary of the Sizes of the Price Increases (Excluding Energy, Postal Services, Rental Fees, Insurances in November 2006–March 2010)*

| Models | Explanatory Variables: | Panel I Size increase | Panel II Size increase |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| State-dependent | -Inflation | Rejected | Supported |
| | -Attractive pricing | Not tested | Not tested |
| Time-dependent | -Season | Rejected | Not tested |
| | -Regulation | Supported | Supported |
| | -Political business cycle (pre-election) and the Energy Fund | Supported | Supported |

## 4.5. Conclusions

The main objective of this chapter was the exploration of the determinants of price change frequencies using SDP and TDP. Panel analysis was used to test the consistency of the price-rigidity theories with the data for Curaçao in 2006−2010. The panel data excluded the energy prices, insurance, rental fees, and postal services. The panel data were categorized into two datasets, as follows: The first dataset was classified by product type (the CPI categories), and the second was classified by type of commodity, including non-durables, semi-durables, services, and combinations of types of commodities.

In both panel datasets, the hypotheses of inflation and attractive pricing were rejected. Alternatively, political interference in the periods of pre-elections (political business cycle) and the Energy Fund (as regulatory capture) was significant in the categories of non-durables and semi-durables in Panel II. Seasonality was tested and supported in the panel data classified

according to CPI categories, namely the month of January for the category of “clothing and footwear” and the month of February for all CPI categories.

The SDP hypotheses of inflation and attractive prices were rejected. Meanwhile, the TDP hypotheses of seasonality and political interference were supported. Prices were sticky in the months of February and in January in “clothing and footwear.” In addition, political interference in the periods of pre-elections and the Energy Fund caused price rigidity in Curaçao. Hence, there is evidence that sticky prices are the result of TDP.

The political interference hypothesis in the periods of pre-elections and the Energy Fund was supported in one panel but rejected in the other; this implies that this hypothesis is sensitive to the classification system of the commodities. The reason for the support in one panel was that the price setting of political interference indirectly affected a broad range of commodities. As a consequence, the impact of political interference was captured by the panel with a broader classification system than CPI product type classification.

Admittedly, most of the SDP and TDP hypotheses were rejected. This can be ascribed to the origin of the price-rigidity theories, which were generated for large, developed economies. As micro-islands were not expected to have price rigidity, these theories may not be applicable to this group. In contrast to the majority of price-rigidity hypotheses, the political interference hypothesis, formulated particularly for explaining the price rigidity in Curaçao, proved to help clarify the price-rigidity puzzle.

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## Appendix 4A: A Detailed Description of the Micro-Dataset of Curaçao

### Data Compilation

The dataset consisted of the unpublished monthly retail price quotes. The field agents of the CBS in Curaçao collected the data at selected outlets to construct the CPI. Prices were collected on a monthly, bi-monthly, quarterly, bi-annual, or annual basis during the period of October 2006–March 2010. Approximately 50 specific outlets were visited during the first 2 weeks of every month. In addition, 50 outlets were visited bi-monthly or on a quarterly basis. The list with products to be reviewed by the field agents contained the product description, units of measurement, material description, and occasionally the brand name. The code system in use was developed by the CBS and shows great similarity to the UN's international code system, namely the COICOP. Each product code has 5 numbers; for example, item 11511 is "white rice Blue Ribbon" at 5 lbs. This item is classified under subcategory 11000 of "cereals, flour, and bakery product" and under the category "10000" of "food" (Table 4A).

Table 4A

*General Information on the CPI Database of Curaçao (October 2006–March 2010)*

| Code (1) | Categories (2) | Price trajectories (3) | Monthly coverage (on average, %) (4) | CPI weights based on Budget Survey 2006 (5) |
|---|---|---|---|---|
| **10000** | **FOOD** | **3,248** | **81** | **12.3** |
| 11000 | Cereals, Flour, & Bakery Product | 393 | 72 | 1.9 |
| 12000 | Meats & Fish | 552 | 77 | 2.5 |
| 13000 | Edible Fats & Oils | 108 | 68 | 0.3 |
| 14000 | Dairy Products | 305 | 69 | 1.0 |
| 15000 | Fruits & Vegetables | 669 | 77 | 1.6 |
| 16000 | Sugar | 169 | 85 | 0.3 |
| 17000 | Ready Meals | 142 | 80 | 0.6 |
| 18000 | Outdoor Consumption | 341 | 93 | 3.4 |
| 19000 | Other Food Products | 569 | 96 | 0.8 |
| **20000** | **BEVERAGES & TOBACCO** | **528** | **84** | **1.6** |
| **30000** | **CLOTHING & FOOTWEAR** | **388** | **71** | **4.8** |
| **40000** | **HOUSING** | **347** | **80** | **30.8** |
| 43000 | Home Maintenance | 239 | 81 | 2.6 |
| 44000 | Gardening | 104 | 75 | 0.9 |
| 41/42/45000 | Energy & Rent | 4 | 100 | 27.4 |
| **50000** | **HOUSEHOLD FURNISHING & APPLIANCES** | **847** | **65** | **7.0** |
| 51000 | Furniture & Lighting | 115 | 57 | 1.3 |
| 52000 | Upholstery & Soft Furnishing | 95 | 88 | 0.8 |
| 53000 | Home Tools & Equipment | 161 | 44 | 1.0 |
| 54000 | Household Items | 278 | 64 | 0.6 |
| 55000 | Household Expenditure | 171 | 75 | 0.8 |
| 56000 | Household Services | 1 | 100 | 1.2 |
| 59000 | Household Furnishing | 26 | 77 | 1.4 |

| Code (1) | Categories (2) | Price trajectories (3) | Monthly coverage (on average, %) (4) | CPI weights based on Budget Survey 2006 (5) |
|---|---|---|---|---|
| **61000** | **MEDICAL CARE** | **165** | **67** | **1.3** |
| **70000** | **TRANSPORTATION & COMMUNICATION** | **191** | **68** | **22.6** |
| | Expenses for Own Transport | | | |
| 72000 | Vehicles | 160 | 72 | 13.1 |
| 73000 | Transport | 5 | 80 | 5.1 |
| 74000 | Communication | 26 | 42 | 4.4 |
| **80000** | **RECREATION & EDUCATION** | **530** | **62** | **7.7** |
| 81000 | Recreation | 142 | 56 | 3.7 |
| 82000 | Entertainment & Culture | 23 | 96 | 0.7 |
| 83000 | Books, etc. | 73 | 74 | 0.6 |
| 85000 | Educational Material | 274 | 59 | 2.4 |
| 86000 | Hobby Articles | 18 | 50 | 0.2 |
| **90000** | **MISCELLANEOUS** | **526** | **69** | **11.9** |
| 91000 | Personal Body Care | 347 | 73 | 3.3 |
| 92000 | Insurance | 1 | 100 | 4.4 |
| 93000 | Commodities & Services | 178 | 60 | 4.2 |
| | **Total Trajectories** | **6,770** | **75** | **100** |

*Notes.* Source: Central Bureau of Statistics Curaçao

The first and second columns of Table 4A show the code classification and the product description. The dataset consisted of 9 categories, 30 subcategories, and 363 item codes. The 9 categories are listed in bold in the second column of Table 4A. The 30 subcategories are listed under the categories in Column 2. Item codes represent a group of similar products of various brands, so each item code covers several brands in several outlets. A price trajectory refers to a series of price quotes for a specific article of a specific brand observed in a specific outlet. The price trajectories observed covered 6,770 goods and services (Column 3). On average, 75% of the listed good and services are covered each month (Column 4). The categories of "communication" and "home tools and equipment" were underreported because several items

(e.g., telephones, washing machines) were out of stock or discontinued.

The CPI weights in Table 4A (Column 5) show the relative importance of each (sub) category in the total CPI. CPI weights are assembled by the CBS in the budget surveys held every 5 years. The CPI weights are from the Budget Survey 2006. A higher relative weight does not necessarily mean a greater amount of price trajectories. Rather, the number of price trajectories is a reflection of the assortment of a product. The price frequency of, for example, the subcategory "energy & rent" of the CPI is measured by four trajectories, namely "rent," "water," "gas cylinders," and "electricity," coinciding with a substantial CPI weight of 27.4%. In Curaçao, each product in the energy sector is produced by a separate (state-owned) monopoly. Hence, each product item has only one price trajectory.

**Estimated Data and Indices in the CPI Micro-dataset of the CBS**

The category "rent" was estimated by the CBS by assuming a monthly increase of 0.2%, which is based on estimates deducted from the Budget Survey 2006. The prices of energy, insurance, and postal service tariffs were entered as indices in the micro-dataset. The data on energy prices were collected from the general information system (websites) of the companies providing utilities in Curaçao. Health tariffs, insurance, and postal service tariffs are adjusted once a year; hence, these data are collected annually by the CBS. It is worth mentioning that for tuition, only one price trajectory was accounted for in the CPI dataset, despite the numerous private and public education systems.

**Duration Spells**

Figure 4A shows the price trajectory of a food product, 5 lbs. of "Blue Ribbon" at an unnamed outlet (in US$). The item code "rice" has 70 price trajectories in the dataset. A price trajectory consists of price spells, which are periods of an unchanged price. Figure 4A shows

that this product had six price spells in the sample period. Most price trajectories are left and right-censored, as it is not known when the first or last price spell started or ended. This item includes four completed price spells.

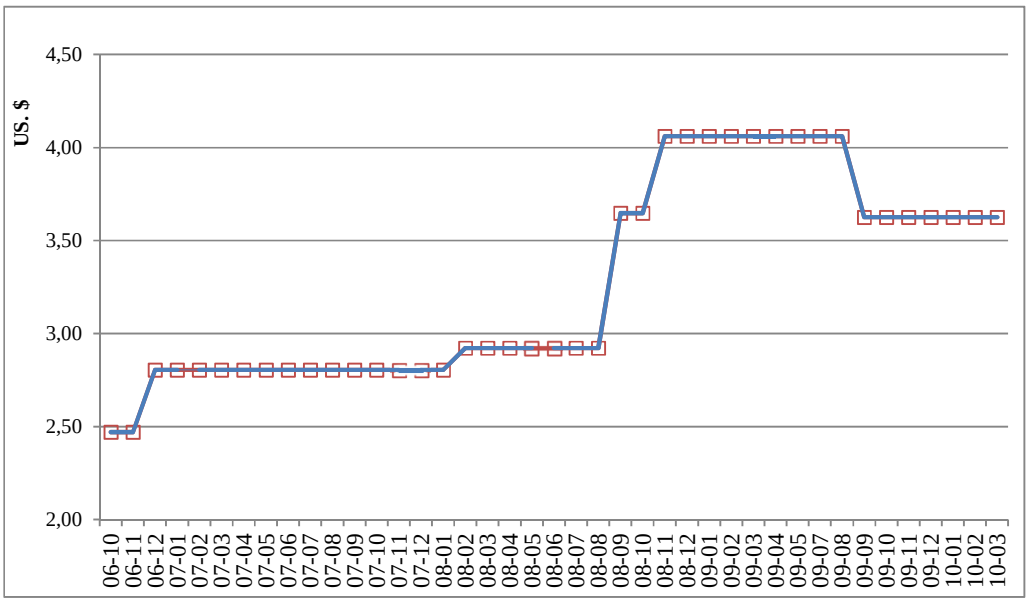


*Figure 4A*. Price trajectory of 5 lbs. of "Blue Ribbon" white rice (in US$ for the period of 2010.10–2006.03). Source: CPI micro-data from the CBS.

**Converting Micro-data to Binary Variables.**

The micro-data were converted to binary variables for Equations (4.1) to (4.13). To convert the data on price quotes into binary variables, the Microsoft Office Excel 2007 software program was used. The binary dataset had to be re-checked for errors. In this type of data, missing data are very common. As a change in price is programmed to be the change in two consecutive months, computational errors occur in the month following the missing data (seen as a "0"). In addition, on some occasions, within a price spell, the same price is recorded in the months *t-1* and *t+1*. Instead of creating two time spells, it is reasonable to impute the price of the month *t-1* in month *t*. These adjustments occurred in approximately 3% of the price trajectories, and they were adjusted for two adjacent months on average.

Appendix 4B: Regulated Commodities

Table 4B

*The Regulated Commodities in Curaçao in 2009*

| COICOP code | Description | COICOP classification |
|---|---|---|
| 01.1.1.1 | Maize | Bread and cereals (ND) |
| 01.1.1.1 | Rice | Bread and cereals (ND) |
| 01.1.1.2 | Salted meat | Meat (ND) |
| 01.1.1.3 | Salted Fish | Fish and seafood (ND) |
| 01.1.1.4 | Milk | Milk, cheese and eggs (ND) |
| 01.1.1.4 | Powdered milk | Milk, cheese and eggs (ND) |
| 01.1.1.5 | Margarine | Oils and fats (ND) |
| 01.1.1.5 | Cream butter | Oils and fats (ND) |
| 01.1.1.5 | Oil | Oils and fats (ND) |
| 01.1.1.8 | Sugar | Sugar, jam, honey, chocolate, and confectionery (ND) |
| 01.1.1.9 | Baby foods | Food products n.e.c. (ND) |
| 01.2.1 | Tea | Coffee, tea, and cocoa (ND) |
| 01.2.1 | Coffee | Coffee, tea, and cocoa (ND) |
| | | |
| | Tariffs of : | |
| 04.5.1 | Electricity | Electricity (ND) |
| 04.5.2 | Gas (LPG 100 lbs., 20 lbs.) | Gas (ND) |
| 04.5.3 | Kerosene | Liquid fuels (ND) |
| 04.4.1 | Water | Water supply (ND) |
| | | |
| 06.1.1 | Birth control pills | Pharmaceutical products (ND) |
| 06.1.1 | Antidiabetic medicines | Pharmaceutical products (ND) |
| | | |
| 06.2.1 | Consultations of physicians in general or specialist practice | Medical services (S) |
| 06.2.1 | Mental care services | Medical services (S) |
| 06.3.0 | Hospital services | Hospital services (S) |
| 06.2.3 | Ambulance services | Paramedical services (S) |
| 06.2.3 | Paramedical services | Paramedical services (S) |
| | | |
| 07.2.2 | Gasoline 95 octane | Fuels and lubricants for personal transport equipment (ND) |
| 07.2.2 | Gasoil | Fuels and lubricants for personal transport equipment (ND) |

Table 4B

*The Regulated Commodities in Curaçao in 2009*

| | | |
|---|---|---|
| 07.2 | Private Busses | Transport services (S) |
| 07.2 | Public transportation | Transport services (S) |
| 07.2 | Taxi | Transport services (S) |
| 08.1 | Stamps | Postal services(S) |
| 10 | Tuition fees | Education (S) |
| 12.4.0 | Retirement homes for elderly persons, residences for disabled persons | Social protection (S) |
| 12.5.4 | Insurances | Insurance connected with transport (S) |
| n.a. | Asphalt | n.a. |
| n.a. | Sand and bricks | n.a. |
| n.a. | Household services, minimum wage | n.a. |

*Notes.* Source: Department of Economic Affairs; the COICOP classification is the author's compilation.

# CHAPTER 5

# PRICE-SETTING IN THE GASOLINE RETAIL MARKET OF CURAÇAO

Gasoline is an essential combustible, and its price developments are closely monitored by consumers. Consumers in the OECD countries have been complaining about the fact that gasoline prices are asymmetrical. Bacon (1991) referred to the price asymmetric behavior in the gasoline market as "rockets and feathers": Gasoline prices were perceived to rise like rockets following a rise in costs but to go down like feathers when costs decline. The price asymmetry has been confirmed for the European countries of France, Germany, Italy, Spain, and the United Kingdom (e.g., Galeotti, Lanza, & Manera, 2003) and for the United States (e.g., Radchenko, 2005). Grasso and Manera (2007) presented an overview of the numerous studies of the OECD countries on this topic. According to these authors, most studies reported evidence of price asymmetry in their countries' gasoline markets. In some gasoline markets, including that of the Netherlands, inconclusive results on the price asymmetry were obtained. In this country, price asymmetric pricing behavior was found on Monday, Thursday, and Friday, but symmetric price adjustments were evident on Tuesday and Wednesday in the period of 1996−2001 (Bettendorf, van der Geest, & Varkevisser, 2003).

Price asymmetry in the gasoline market is often associated with market power of the price setters operating in oligopolistic gasoline markets (Borenstein, Cameron, & Gilbert 1997; Galeotti et al., 2003). However, Balke, Brown, and Yucel (1998) concluded that there is lack of evidence that price asymmetry "arises from market power" (p. 28). Furthermore, Kaufmann and Laskowski (2005) showed that factors other than market power caused the price asymmetry in the US gasoline market. They concluded that the price asymmetry in the US between crude oil and motor gasoline in the period of 1986–2002 was due to the refinery utilization rate and the

inventory behavior. Obviously, the debate on the causal relationship between market power and price asymmetry is still unsettled (Borenstein & Shephard, 2002; Peltzman, 2000).

The price asymmetry in *liberalized* gasoline markets in developing countries was reviewed by Bacon and Kojima (2010). They reported that "rockets and feathers" price asymmetry was found in Argentina, the Philippines, Russia, Fiji, Colombia, Chile, and Turkey.

Small island states are usually net oil importers and have less resilience to (oil) shocks than the larger economies (Armstrong & Read, 2002; Briguglio, 1995). It is therefore unsurprising that when consumers and firms are confronted with the economic costs of oil price increases, the policymakers of small states are often met by calls for government intervention. Hence, in an attempt to shield both consumers and producers against the price volatility of crude oil and its derivatives, their governments have implemented energy price regulations (Kojima, 2013).

Curaçao is a crude oil importer. The gasoline for the domestic market, a derivative of crude oil, is produced at the local refinery. Similar to the commodity markets on small islands, the hypothesis of flexible prices applies to the gasoline market in Curaçao. Hence, the gasoline prices at the gas stations in Curaçao are expected to adjust frequently following the daily world market gasoline price changes. In addition, the gasoline retail market in Curaçao is characterized by a high number of gas stations (26 gas stations in an area of 444 $km^2$) and a homogenous product of unleaded 95 octane gasoline. The many gas stations and the homogenous product offered at the same price per liter at each gas station may reflect a perfect competitive gasoline retail market. Consequently, the domestic price of gasoline is assumed to adjust with the international gasoline price changes.

Consumers in Curaçao, however, have been complaining about asymmetric gasoline price adjustments (Leidel-Schenk, 2012). Gasoline prices were sticky in the period of

1990−2012, as indicated by the median duration of gasoline prices freezes of 3 months and the durations of price spells varying from 1 month to 25 months compared to the daily international gasoline price adjustments. I argue that the price rigidity in the gasoline retail market is a driver of the larger price-rigidity puzzle of Curaçao, since changes in energy prices affect prices' changes of most non-energy commodities. Explaining the price rigidity in the gasoline market will shed light on the larger price-rigidity puzzle. The aim of this chapter is to identify the causes of price stickiness in the gasoline retail market in Curaçao. The starting point is testing of two common price-rigidity hypotheses, namely the menu costs (Barro, 1972) and the information delays created by an inattentive producer (Reis, 2006). The menu costs hypothesis claims that the costs of changing the price is too high compared to the size of the price adjustment; therefore, the price is kept unchanged. Meanwhile, the information delay hypothesis suggests that an inattentive producer processes information with a lag, and as a result, prices will remain unchanged for a period of time.

A new hypothesis, namely the political interference hypothesis, has been tested for the gasoline retail market. According to the political interference hypothesis in the case of Curaçao, whether inspired by altruism or opportunistic motives, the policymakers of Curaçao occasionally interfere in the frequency and size of gasoline price setting. Hence, the menu costs, inattentive producers, and political interference represent the three hypotheses tested in the gasoline retail market in Curaçao.

This chapter is structured as follows. As the hypotheses of menu costs and the inattentive producer have been discussed at length in the economic literature on price rigidity, the literature review in Section 5.1 focuses on the implications of the hypothesis of political interference in price setting. Section 5.2 describes how the gasoline is distributed from the wholesaler to the gas

station in Curaçao and the price setting in the gasoline market of Curaçao. Section 5.3 presents the autoregressive binomial conditional (ABC), the model used to compare the three hypotheses of menu costs, inattentive producers, and political interference, showing the expected signs of the model parameters for each hypothesis. The data of the model in the period of 1990−2012 are described in Section 5.4. The results of the comparison between the three hypotheses are presented in Section 5.5; these results reveal that the gasoline price data from Curaçao do not support the price-rigidity theories of menu costs and inattentive producers but do support the political interference hypothesis. Price asymmetry is also tested and analyzed. The calculations of cost of economic distortion following the price asymmetry fall outside the scope of this dissertation. Section 5.6 provides the conclusions on the price setting in the gasoline retail markets.

## 5.1. Political Interference and Its Consequences

Political interference in the price setting of the gasoline market includes price regulation and pricing policies based on the political business cycle and regulatory capture. The energy price regulation policy in Curaçao started in 1990, motivated by price stabilization for consumers (de Haan, 1990). This policy is an alternative to the immediate gasoline spot price pass-through policy, which generated high volatility in the domestic gasoline price. The price regulation entails the setting of price ceilings or price floors and the setting of the frequency of the price changes. The frequency was initially every quarter, and since mid-2007, it has been every month, which is consistent with Taylor TDP (Taylor, 1980).

In the pre-election periods in Curaçao, the gasoline price increases were postponed by the policymakers, as these increases would have spoiled their chances of re-election. In contrast, price declines were implemented. This is consistent with the political business cycle (Moita &

Paiva, 2013; Nordhaus, 1975; Schuknecht, 1996). In addition, in times of gasoline price hikes, interest groups pressured policymakers and the regulatory authority to postpone gasoline price adjustments. As a result of this pressure, the regulatory authority collaborated in the period of 2006−2007 with the introduction of the "Energy Fund" (NRC- Handelsblad, 2012). This was implemented to finance the energy price hikes and is consistent with regulatory capture (Dal Bo, 2006).

The consequences for the consumers of the political interference in the pricing of gasoline are not clear cut. This is shown by a few examples concerning price regulation, regulatory capture, and the political business cycle. Governments often use the incomes policy to argue that price regulation leads to more stable prices (Suvankulov, Keung Lau, & Ogucu, 2011). Kojima (2013), however, challenged the positive impact of price regulation on the gasoline retail markets. He argued that price regulation may produce externalities, including inefficient operating firms and rising costs. Hence, price regulation may actually lead to higher prices.

In a system of regulatory capture with regulated prices, the outcome for consumers is ambiguous. The case of regulatory capture in the period of 1999−2000 in Spain had favorable results for the consumers. The Spanish political elite in the dominant oil company (Repsol) carried out the price setting in an oligopolistic gasoline market. The price intervention and regulatory capture in this sector involved the collaboration between this interest group and the government to maintain inflation stability in the 1990s, a period of rising oil prices (Contin-Pilart, Correlje, & Blanca Palacios, 2009). Regulatory capture with price regulation resulted in inflation stability, which was beneficial to the consumer in times of rising oil prices.

Unfavorable to consumers was the case of eight Canadian cities that were subjected to regulatory capture and regulated prices (Sen, Clemente, & Jonker, 2011). In this case, the price ceilings functioned as focal points in the price setting, stimulating firms to set higher prices. The price regulation that was intended to curb the rising gasoline prices resulted in higher prices, creating a loss in purchasing power for consumers. The higher prices benefited firms, which is consistent with regulatory capture, with the interest group of firms gaining the most. Hence, the regulatory capture in this case resulted in benefit to the producers.

Price asymmetry in the reviewed literature is defined as the occurrence of *more frequent price rises* than price cuts, all else being equal. However, the occurrence of *more frequent price cuts* than price rises, all else equal is also price asymmetry. Price asymmetry leads to costs of economic distortion (Borenstein et al., 1997; Sen et al., 2011). Political interference by price regulation, price intervention in the periods of political business cycle, and regulatory capture lead to a price adjustment where price declines are preferred. Thus, political interference leads to price asymmetry.

Bacon and Kojima (2010) introduced the concept of *inverse* rockets and feathers suggesting that, "many countries are reluctant to raise prices quickly, for fear of popular resistance, and anxious to reduce them as soon as economically viable" (p. 13). As a result, "governments even exhibit an inverse rockets and feathers pattern" (p. 13). A study performed by Mitchell and Craigwell (2009) explored the price asymmetry in the gasoline markets in the micro-islands of Antigua, Dominica, and Barbados in the period of 2000−2007. In Antigua and Dominica, price increases persisted more than decreases. As international gasoline prices were more frequent than price declines, this was consistent with rockets and feathers. Conversely, in

Barbados, more price declines than price increases were found. As international price increases occurred more often, this may be an indication of a case of inverse rockets and feathers.

To summarize, in the gasoline markets, prices rise like rockets and fall like feathers. Inverse rockets and feathers also infrequently occur in this market. When the pricing behavior leads to price asymmetry, it brings about costs of economic distortion, which are a disadvantage to either consumers or producers. The hypothesis of political interference in price setting suggests that price regulation, the political business cycle, and regulatory capture lead to price asymmetry and economic distortion. Political interference in price setting is one of the hypotheses that is tested for causing price rigidity in the gasoline sector of Curaçao.

## 5.2. Gasoline Pricing in Curaçao

This section provides a description of the various stages of gasoline distribution in Curaçao and discusses their pricing. It includes comparative analysis with other countries and the political interference in the pricing of the gasoline retail market.

### 5.2.1. Gasoline Distribution Chains

Borenstein et al. (1997) posited that the speeds of price adjustments vary according to the "points" or stages in the distribution chains. Figure 5.1 shows the stages in the distribution chain in the gasoline market of Curaçao. The first stage is the oil refinery in Curaçao, namely Refineria di Kòrsou.[28] Oil tankers from Venezuela supply the crude oil to the oil refinery. The refinery produces and supplies refined oil products to the international and domestic markets. It has an inventory level of unleaded gasoline 95 octane of approximately 8 months of local demand (J. Hernandez, personal communication, April 19, 2013).

[28] The oil refinery in Curaçao was established in 1914 by the "Royal Dutch Shell Company," or the Shell. The Shell ceased its operation in 1985 and the refinery was handed over to the government of Curaçao, which until the present has leased the oil refinery to the Venezuelan company, Petróleos de Venezuela S.A. (PDVSA).

The second stage is the distribution to the wholesaler, Curoil a state-owned natural monopoly (Curoil, 2013). The refinery delivers the gasoline by pipelines to Curoil's oil tanks. Curoil stores and distributes the generic unleaded 95 octane gasoline[29] and other oil derivatives. The company has small storage capacity, and hence, there is no excessive inventory of gasoline (E. Paulina, personal communication, April 23, 2013). The last stage of distribution is the delivery on demand to the gas stations by tank wagons. Curaçao has a high density of gas stations in comparison to other Caribbean micro-SIDS, with 26 self-service gas stations—equivalent to 1 gas station per 17 $km^2$. The densities of other micro-SIDS (denoted in $km^2$ served by one gas station) are as follows: Aruba: 21 $km^2$, Barbados: 24 $km^2$, Dominica: 50 $km^2$, Saint Lucia: 51 $km^2$, and Montserrat: 52 $km^2$. Larger economies, for example, the United States and United Kingdom, have one gas station per 50–80 $km^2$ and one per 71 $km^2$, respectively.[30]

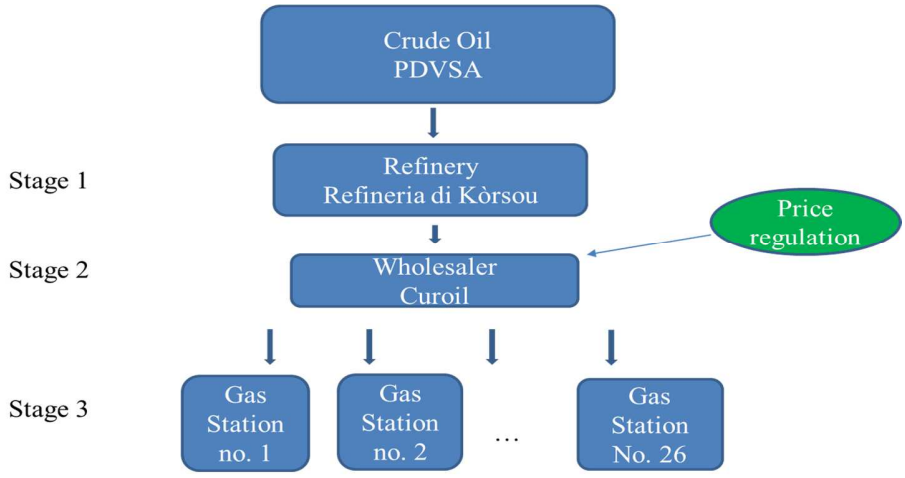


*Figure 5.1.* Gasoline distribution chains in Curaçao.

[29] The sale of leaded 92 octane gasoline was discontinued in 2009.

[30] This information was retrieved from the websites of the respective countries: arubayp.com, barbadosyp.com, dominicayp.com, stluciayp.com, montserratyp.com, fueleconomy.gov, (the US), accessed on December, 11, 2013. The data of the UK are retrieved from Contin-Pilart, Correlje and Blanca Palacios (2009, p. 221).

### 5.2.2. Pricing Procedures

The crude oil spot prices on the world market are set daily in an oligopolistic market structure that is dominated by the Organization of the Petroleum Exporting Countries (OPEC).[31] PDVSA, the Venezuelan oil company that runs the oil refinery in Curaçao, applies the West Texas Intermediate (WTI) crude oil price to calculate the cost price of oil of the refinery in Curaçao (J. Hernandez, personal communication, April 19, 2013).

In the first stage of the distribution chain in Figure 5.1, which represents the level of the refinery, the acquisition price of gasoline is set equal to the conventional gasoline spot price of the Platts' Gulf price system, effective on the date of the completion of the gasoline delivery to Curoil (E. Paulina, personal communication, April 23, 2013). In the second and third stages of the distribution chain, the wholesale and retail gasoline prices are regulated by the government. The regulation involves time-dependent price setting where the "contract" period (Minister van Financien, 2011) and a price ceiling (P. B. No. 117, 1961; P. B. No. 203, 1982) are set. To change the gasoline wholesale and retail prices, the regulatory authority[32] has to submit a proposal for price adjustment in a prearranged period[33] to the Minister of Finance. Two days after the approval by the Minister of Finance, the regulatory authority must publish the new prices in three local newspapers. The price changes will be effective as of the first workday following the week of the approval by the Minister of Finance (Bureau Telecommunicatie en Post, BTPU2013/DIR-152, personal communication, May 16, 2013).[34]

[31] Venezuela, the oil provider of the refinery in Curaçao, is a member of the OPEC.

[32] In 2010, the "Bureau Telecommunicatie en Post" was assigned as the regulatory authority of the energy prices (Bureau Telecommunicatie en Post, (BTPU2015/DIR-092, personal communication, May 12, 2015).

[33] Every month since mid-2007.

[34] The private gas stations are represented by the three associations of Asogas, Vanddis, and Copda; the state-owned gas stations are owned by Curoil.

The wholesaler provides two engine combustibles, namely gasoil and unleaded 95 octane gasoline, to the gas stations. Both are chemically homogenous products. The gas stations, of which 21 are privately owned and 5 are state-owned, operate in an oligopolistic market structure, and the retail margin per liter of gasoline is prearranged. Retailers offer the gasoline at the regulated price; to increase their sales, a strong customer relationship is necessary. To increase the market share, retailers compete by adding services (pay-as-you-go electricity, prepaid telephone cards), offering miles' savings, or introducing raffle prizes. The gasoline retail price components are listed in Table 5.1; they consist of (a) the acquisition price of gasoline, (b) a fixed margin for Curoil, (c) excise tax, (d) a correction factor/recovery index, (e) a cross-subsidy for other regulated energy products, (f) sales tax (6%) on wholesale trade, (h) sales tax (6%) on the retail trade, and (g) a fixed retail margin for the gas station.

Table 5.1

*Gasoline Unleaded 95 Octane Price Structure in Curaçao (US$)*

| Price breakdown | Calculation per liter | Price per liter Sept. 1, 2015–Oct. 5, 2015 |
|---|---|---|
| Purchase price | a | 0.57 |
| Margin Curoil | b | 0.05 |
| Government taxes | c | 0.23 |
| Recovery premium index | d | 0.07 |
| Cross-subsidy [1] | e | 0.00 |
| Sales tax[2] on wholesale | f=(a+b+c+d+e)*sales tax (%) | 0.05 |
| Margin gas stations | g | 0.09 |
| Sales tax on retail trade | h=(a+b+c+d+f+g)*sales tax (%) | 0.06 |
| *Retail price* | i=a+b+c+d+f+g+h | 1.12 |

*Notes.*

1. Cross-subsidy for the LPG (cooking gas)
2. The sales tax was introduced in 1996.

Source: www.btnp.org (Bureau Telecommunicatie en Post). This price structure has been in place since 2011. The date accessed is October 30, 2015. The author's codes are shown in the second column. The gasoline price represents September 2015 and ends October 5, 2015.

A positive recovery index is included to recover the pre-financed amounts because the regulated price was set to low in the previous month/quarter and zero when no recovery was needed. Otherwise, the excessive amount of a regulated price that was set to high in the previous period will be deducted in the current recovery index by adding a negative recovery index. The margins of Curoil and the gas station, as well as the taxes,[35] are adjusted by the government. No policy exists on either the frequency or the size change of the prearranged retail margin. The cross-subsidy is the amount of cents per liter of gasoline the consumer has to pay for Curoil to maintain a price freeze for *cooking gas*.[36]

### 5.2.3. The Taylor and Calvo TDP

Government intervention in the price setting in the gasoline retail market of Curaçao is motivated by price stability (P. B. No. 117, 1961). The government of Curaçao engaged in the regulation of the retail gasoline prices with policy guidelines on the frequency with which gasoline prices can change and on gasoline price ceilings. The frequency was stipulated by a contract period of a quarter in the period of 1990−2005 and every month since mid-2007, which is consistent with Taylor TDP. In the period of 2006 until mid-2007, the gasoline prices remained fixed and were subsidized through the Energy Fund.

[35] The government excise tax (item c) was reduced from 35.20¢ per liter in 2010 to 26.40¢ in 2012; it was further reduced to 23¢ in 2013.

[36] Since 2011, the new policy of the government is to maintain the prices of the cooking gas/ propane /butane or the liquid petroleum gas (LPG), the LPG 20 lbs. and LPG 100 lbs., fixed. Cooking gas is partly financed through cross subsidy, which is included in the prices of the gasoline and gasoil (Bureau Telecommunicatie en Post, BTPU2015/DIR-092, personal communication, May 12, 2015). Hence, the car drivers are partly subsidizing the cooking gas.

Table 5.2

*Gasoline Retail Price Changes in Curaçao (1990-2012)*

| Year | Number of changes | Total number of price increases | Total number of price decreases | Average price increase in US ¢ | Average price decrease in US ¢ |
|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) |
| 1990[a] | 3 | 3 | 0 | 4.33 | 0.00 |
| 1991[a] | 3 | 0 | 3 | 0.00 | – 3.00 |
| 1992 | 0 | 0 | 0 | 0.00 | 0.00 |
| 1993 | 1 | 1 | 0 | 3.00 | 0.00 |
| 1994[a] | 1 | 0 | 1 | 0.00 | – 3.00 |
| 1995[a] | 2 | 2 | 0 | 3.50 | 0.00 |
| 1996 | 3 | 3 | 0 | 4.00 | 0.00 |
| 1997 | 0 | 0 | 0 | 0.00 | 0.00 |
| 1998[a] | 1 | 0 | 1 | 0.00 | – 4.00 |
| 1999[a] | 3 | 2 | 1 | 5.00 | – 4.00 |
| 2000 | 2 | 2 | 0 | 6.50 | 0.00 |
| 2001 | 3 | 1 | 2 | 6.00 | – 4.00 |
| 2002[a] | 4 | 3 | 1 | 6.33 | –17.00 |
| 2003[a] | 4 | 2 | 2 | 3.00 | – 5.50 |
| 2004 | 1 | 1 | 0 | 5.00 | 0.00 |
| 2005 | 2 | 2 | 0 | 7.00 | 0.00 |
| 2006[a.b] | 0 | 0 | 0 | 0.00 | 0.00 |
| 2007[a.b] | 2 | 2 | 0 | 4.00 | 0.00 |
| 2008 | 6 | 4 | 2 | 8.75 | – 9.00 |
| 2009 | 9 | 4 | 5 | 10.50 | –12.33 |
| 2010[a] | 1 | 1 | 0 | 6.00 | 0.00 |
| 2011 | 4 | 1 | 3 | 21.00 | – 2.00 |
| 2012[a] | 6 | 4 | 2 | 5.08 | – 5.50 |
| Total | 61 | 38 | 23 | 5.74 | – 6.30 |

*Notes*.

[a.]Election year; elections are held every 2 years, alternating between the island and federation (central) level.

[b.]Energy Fund in the mid-2006–mid-2007 period.

Sources: Authors' calculations based on information from (Curoil, 2013), CBS, Statistical Yearbooks.

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Columns 2–4 of Table 5.2 present the number of gasoline price changes per year in the period of 1990−2012. The total number of price changes is partitioned into the numbers of price

increases and price declines. In the period of 1990−2006, the proposed policy for price changes was that they could occur every quarter. However, the number of price changes (four) only coincided with the proposed pricing policy in 2002–2003. In 1990−2006, excluding the period of 2002−2003, the price adjustments did not meet the proposed policy. In mid-2006−mid-2007, the price remained fixed and the price increases were subsidized by the Energy Fund.[37] It was proposed that the energy price should be adjusted after this fund was depleted. Starting in mid-2007, the "contract" period of the gasoline prices changed from quarterly to monthly. As a result of the new price regulation policy, gasoline prices were projected to change 12 times per year. However, in 2008 only 6 of the 12 price changes were implemented, and in 2009, 9 out of the 12 price changes were reported. The period of 1990−2012 was marked by repeated deviations from the proposed pricing policy.

It is common for the incumbent politicians in Curaçao to postpone the decision on gasoline price increases in pre-election periods, which is consistent with the political business cycle hypothesis. Price increases combined with unchanged nominal income lower the purchasing power and will reduce the chances of the incumbent policymaker being re-elected. In Table 5.2, the election years are indicated by the letter "a." A postponement in a price increase will result in a lower number of price changes. With the exception of the years 2002 and 2003, the number of price changes did not reach the maximum number of expected price changes. The maximum number of price change frequencies in election years 2002 and 2003 are best explained in combination with the last two columns (5 and 6) of Table 5.2, which shows the average price increases and decreases.[38] In the election years 2002 and 2003, the average price

[37] The Energy Fund is indicated by "b."

[38] The average price increase can be calculated by the division of an increase (a positive number) in Column 3 of Table 5.3 and Column 3 of Table 5.2. Similarly, the price decrease is the division of a decline (a negative number) in Column 3 of Table 5.3 and Column 3 of Table 5.2.

declines are greater than the average price increases. Price declines in times of elections are favorable for the incumbent policymaker, which most likely will boost his or her chances of re-election. These data are an indication of the political business cycle in the gasoline sector.

### 5.2.4. Unsynchronized Pass-through

Table 5.3 gives the development in the price adjustments of in Gulf Coast gasoline per year, $\Delta\ P_t^*$ (the second column), and the retail gasoline in Curaçao, $\Delta P_t$, (the third column) in US cents per liter. The *price–cost change* is defined as the difference between the *change* in the regulated domestic gasoline price and the *change* in international market spot gasoline price (the cost). In 1993, for example, the Gulf Coast prices (input costs) declined by 3.86¢ and the retail prices increased by 3.13¢ in Curaçao; hence, the price–cost change is approximately 7¢. The components of the price–cost change is shown in Figure 5.2.

Table 5.3

*Price Changes in the Gulf Coast Gasoline and Gasoline Retail Sector in Curaçao (US ¢, 1990–2012)*

| Year | Gulf Coast price changes in ¢ per liter | Retail price changes in ¢ per liter |
|---|---|---|
| (1) | (2) | (3) |
| 1990 | 3.04 | 12.91 |
| 1991 | –3.49 | –8.49 |
| 1992 | –0.24 | 0.00 |
| 1993 | –3.86 | 3.13 |
| 1994 | 1.85 | –3.24 |
| 1995 | 1.24 | 6.87 |
| 1996 | 4.47 | 12.35 |
| 1997 | –3.97 | 0.00 |
| 1998 | –5.40 | –3.91 |
| 1999 | 9.50 | 6.48 |
| 2000 | 1.77 | 13.13 |
| 2001 | –5.61 | –2.29 |
| 2002 | 7.20 | 1.13 |
| 2003 | 1.93 | –4.37 |
| 2004 | 4.79 | 4.64 |
| 2005 | 14.05 | 14.03 |
| 2006 | 0.85 | 0.00 |
| 2007 | 17.94 | 8.10 |
| 2008 | –35.58 | 16.70 |
| 2009 | 25.32 | –18.88 |
| 2010 | 11.19 | 6.17 |
| 2011 | 6.19 | 16.01 |
| 2012 | – 1.83 | 9.55 |
| Total price changes in 1990–2012 | 51.35 | 90.00 |

*Notes.*
The data contain rounding errors
Source: Energy Information Administration, (Curoil, 2013)

Curoil initially evaluated the price–cost changes every quarter; since mid-2007, this has been done every month. A negative monthly/quarterly price–cost change, $\Delta P_t - \Delta\ P_t^* < 0$, means that Curoil has been pre-financing this difference. Curoil is allowed to recapture advance

payments with future retail price adjustments by including a "recovery index premium" (Table 5.1) in the future prices of gasoline. A positive monthly/quarterly price–cost change, $\Delta P_t - \Delta P_t^* > 0$, is discounted by including a negative "recovery index premium" in the future price adjustments (de Haan, 1990). The components of the price structure, except for the cross-subsidy and the recovery index, are largely fixed amounts. The difference between the two lines in Figure 5.2, ceteris paribus, can be considered as an approximation of the recovery index premium and the cross-subsidy.

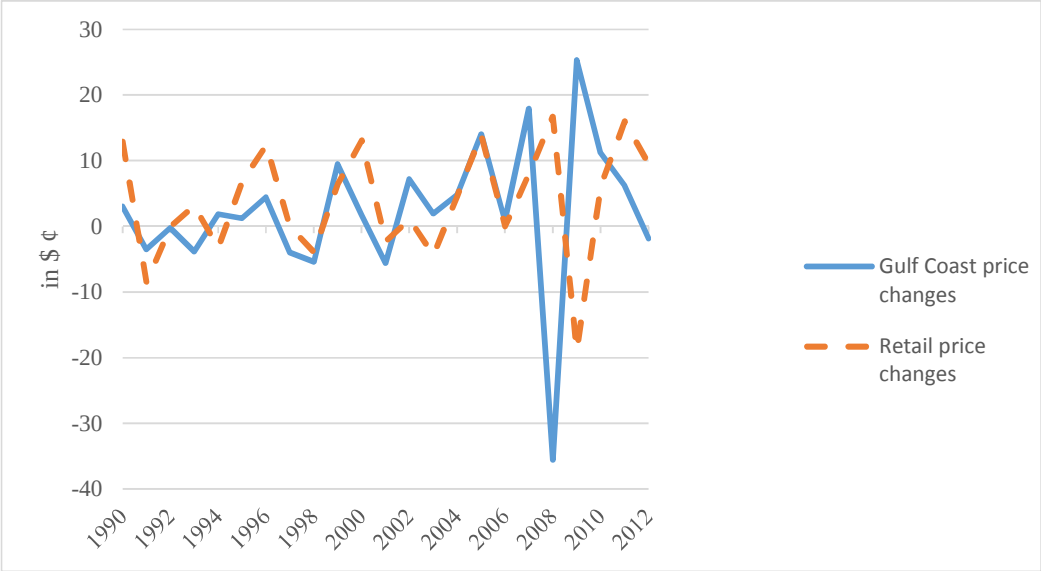


*Figure 5.2.* The components of the price–cost change of gasoline in Curaçao (in US ¢, 1990–2012). Source: Energy Information Administration, Curoil (2013.)

Figure 5.3 shows the cumulative Gulf Coast price changes and the cumulative gasoline retail price changes in the period of 1990–2012. In this period, the total cost change in the Gulf Coast amounted to an increase of 51¢; in Curaçao, the retail price increase was 90¢, representing a price–cost change of 39¢. The wedge between the two lines is the cumulative price–cost changes. The cumulative retail price changes lagged behind the cumulative Gulf Coast price changes caused by unsynchronized pass-through of the Gulf Coast prices in 1992, 1993, 1997,

2003, 2006, 2008, 2009, and 2012. A widening of the cumulative price–cost change occurred when the sizes of the domestic price adjustments differed from the Gulf Coast price changes, mainly due to the gasoline price component of the recovery index premium.

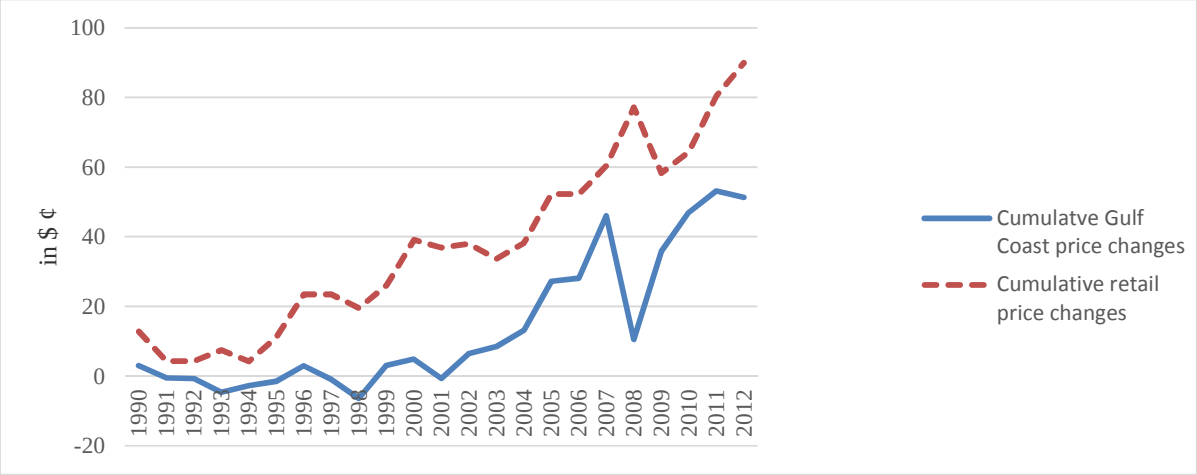


*Figure 5.3.* Cumulative price changes in the Gulf Coast gasoline and the gasoline retail sector in Curaçao (in US ¢, 1990–2012). Source: Energy Information Administration, (Curoil, March 20, 2013).

### 5.3. The Autoregressive Binomial Conditional Model of Gasoline Price Adjustment

Douglas and Herrera (2010) extended the models used by Davis and Hamilton (2003) and proposed the ABC model. The ABC model of Douglas and Herrera (2010, 2014) has a general form with a high degree of flexibility to test the competing theories, such as the menu cost, inattentive producer, and the political interference hypotheses. This ABC model also offers the possibility of testing for asymmetric pricing behavior. In this model, the probabilities of the change in gasoline retail price are related to the current price–cost gap, the lagged probabilities of the gasoline retail price changes, and lagged price adjustment. The current price–cost gap is defined in Douglas and Herrera (2010) as the difference between the cash price of bulk unleaded gasoline (the input cost) and the wholesale price of gasoline, while the price–cost gap is defined

as the difference between the wholesale price and the retail price of gasoline. Hence, the definition of the price–cost gap is related to the data under study.

### 5.3.1. The Autoregressive Binomial Conditional Model

In the ABC model, the probability of a price change will depend on past distributions of actual price changes, past actual price changes, and the price–cost margin between the wholesale/retail price and the targeted optimal price. The time period in this model, *t*, is a day. Gasoline price changes are binomial (the event $x_{t+1} = 1$ represents a change of price, and the event $x_{t+1} = 0$ represents an unchanged price).

The probability that a price change will be introduced at time $t$+1 is defined by the following:

$$h_{t+1} \equiv \Pr(x_{t+1} = 1 | x_t, x_{t-1}, \ldots, x_1, \boldsymbol{z}_t). \quad (5.1)$$

Thus, at time $t$+1, $x_{t+1} = 1$ if a price change is observed, and $\boldsymbol{z}_t$ is the predetermined variable.

In the ABC($q$,$r$,$s$) model, the $q$ refers to the number of parameters of the "error" terms, $r$ is the number of past probabilities, and $s$ is the number of parameters of the actual values of the price change. The ABC($q$,$r$,$s$) model is described by the two following equations:

$$G^{-1}(h_{t+1}) = \omega + \sum_{j=1}^{q} \alpha_j \left(x_{t-j+1} - h_{t-j+1}\right) + \sum_{j=1}^{r} \beta_j \, G^{-1}\left(h_{t-j+1}\right) + \sum_{j=1}^{s} \delta_j x_{t-j+1} + \gamma \boldsymbol{z}_t , \quad (5.2)$$

and

$$h_{t+1} = G\left[\omega + \sum_{j=1}^{q} \alpha_j \left(x_{t-j+1} - h_{t-j+1}\right) + \sum_{j=1}^{r} \beta_j \, G^{-1}\left(h_{t-j+1}\right) + \sum_{j=1}^{s} \delta_j x_{t-j+1} + \gamma \boldsymbol{z}_t\right]. \quad (5.3)$$

Equation (5.3) shows that the probability of a change in price at time $t$+1 depends on a constant, ω, an "error" term $x_{t-j+1} - h_{t-j+1}$ (error on prediction of the actual values), the $t$-$r$ past probabilities on price changes of the link function $G^{-1}(.)$, the past $s$ actual values of $x_t$ , and $\boldsymbol{z}_t = |P_{t-1} - P_{t-1}{}^{*}|$. Here , $P_t$ is the price at time $t$, and $P_t{}^{*}$ is the firm's targeted optimal price. Moreover, $\boldsymbol{z}_t$ is defined as the price–cost gap.

The function G ( ) is a continuous cumulative distribution function (c.d.f.); hence, strictly increasing. $G^{-1}(.)$ represents a one-to-one mapping of $h_{t+1}$ to **R**. Davis and Hamilton (2003) compared the logistic and standard normal functions using the gasoline data for the United States; based on the Schwartz criterion (SC), they concluded that the logistic function offers a better fit. Hence, G is a logistic cumulative density function (c.d.f), $G(v) = \frac{1}{1+e^{-v}}$), and for $q = r = s = 0$, the ABC(0,0,0) is equivalent to the "atheoretical" logit specification in Davis and Hamilton (2003). Given initial conditions of $x_{t,}$ and $h_{t,}$[39] the price change probabilities can be obtained recursively. The parameters $\theta = \{\omega, \alpha_{1,} \dots, \alpha_{q,} \beta_{1,} \dots, \beta_{r,} \delta_{1,} \dots, \delta_{s} , \gamma\}$ are obtained by maximizing the likelihood function, as follows:

$$L = \sum_{t=\max\{q,r,s\}+1}^{T-1} [\, x_{t+1} \log(h_{t+1}) + (1 - x_{t+1}) \log(1 - h_{t+1})]. \quad (5.4)$$

In Douglas and Herrera (2010), the variable $\left|P_{w1(t)} - P_{w1(t)}^{*}\right|$ is defined as the amount remaining from the price–cost gap (due to partial adjustment) after the most recent price change. This variable provides information on whether the price adjustment is full or partial. A partial price adjustment may result in future price adjustments, aiming to reach to a full price adjustment.

### 5.3.2. Autoregressive Binomial Conditional Model Adjustments for the Case of Curaçao

In the case of Curaçao, the time period, *t*, of the model is a month, which differs from the daily observations in the original ABC model. In the United States, the gasoline wholesale/retail prices may change daily, while in Curaçao, a retail price change will take at least 1 month. The interpretation of time can be changed without loss of generality, as this does not alter the model structure. A second adjustment is the frequency of gasoline price change. In the study of

[39] Douglas and Herrera (2010) proposed setting the following initial values of $G^{-1}(h_o)$ =0 and initializing $\omega, \alpha_{j,}$ *and* $\delta_{j,}$ at random. It is then possible to calculate $G^{-1}(h_1), G^{-1}(h_2)$ and so forth.

Douglas and Herrera (2010), the gasoline prices changed daily. In the observed period the change in gasoline prices was mainly based on a quarterly price setting. As a result, the lag of 3 months marked the price-regulation behavior. Therefore, the price–cost gap $|P_{t-3} - P_{t-3}^{*}|$ would offer more information than the proposed price–cost gap with a lag of 1 day ($|P_{t-1} - P_{t-1}^{*}|$, ) as in the study of Douglas and Herrera (2010).

Another adjustment in the ABC model is the definition of the partial price adjustment gap, $|P_{w1(t)} - P_{w1(t)}^{*}|$. The newly defined partial price adjustment gap represents the absolute difference in gasoline retail price change, $\Delta P_t$, and the imported cost change in period *t* (the change in the Gulf Coast spot price), $\Delta P_t^{*}$. Thus, it is equal to the absolute price–cost change $|\Delta P_t - \Delta P_t^{*}|$. This partial price adjustment gap (in changes) differs from the price–cost gaps (in levels) in the studies of Douglas and Herrera (2009, 2014). The newly defined partial price adjustment gap can be rewritten in the absolute values of the domestic gasoline price change $|\Delta P_t|$ and the gasoline imported cost price change $|\Delta P_t^{*}|$. The following inequality holds:

$$|\Delta P_t - \Delta P_t^{*}| \geq abs(|\Delta P_t| - |\Delta P_t^{*}|). \quad (5.5)$$

This can also be expressed as follows:

$$|\Delta P_t - \Delta P_t^{*}| \geq \begin{cases} |\Delta P_t| - |\Delta P_t^{*}|, & if\ |\Delta P_t| \geq |\Delta P_t^{*}| \quad (5.5a) \\ -|\Delta P_t| + |\Delta P_t^{*}|, & if\ |\Delta P_t| \leq |\Delta P_t^{*}|. \quad (5.5b) \end{cases}$$

The aim of the incomes policy of the government of Curaçao is to achieve price stability,[40] which is equivalent to a government striving for small values of $|\Delta P_t|$. These small values are similar to low price changes (inflation) of gasoline. Equation (5.5*a*) presents a situation where the domestic gasoline inflation is higher than the imported gasoline inflation,

[40] P. B. No. 117 (1961).

while Equation (5.5*b*) shows the opposite situation. Hence, the lower domestic gasoline inflation is applicable in Equation (5.5*b*). Hence, with low inflation, $|\Delta P_t - \Delta\ P_t^*| \geq\ |\Delta\ P_t^*|$, meaning that the absolute price–cost change will be at least equal to the absolute foreign price change. Thus, when the foreign prices $|\ \Delta P_t^*|$ increase, the price–cost changes will likely increase. At the same time, an increase in the foreign prices is likely to increase the domestic prices, as the foreign price is the cost factor of the domestic price. Hence, the coefficient of the partial price adjustment gap $\left|P_{w1(t)} -\ P_{w1(t)}{}^*\ \right|$ is expected to be positive.

**The menu cost hypothesis in the autoregressive binomial conditional model.** The probability of a gasoline price change in a menu cost model depends on the *current* price–cost gap. In the menu cost hypothesis, firms review prices based on *current* information on the price–cost gap and the menu cost (Barro, 1972).[41] Firms will change their prices only when the additional profit exceeds the costs for changing the price (the menu costs). Table 5.3 shows the expected coefficients of past distribution, $G^{-1}\ (h_{t-1})$, the past changes, $x_{t-1}$, the partial price adjustment gap, $\left|P_{w1(t)} -\ P_{w1(t)}{}^*\ \right|$, the price symmetry, the political business cycle and Energy Fund, and the price–cost gap with 1 and 3 month lags.

In the menu cost model, $\beta_j\ = \delta_j\ = 0$ (Douglas & Herrera, 2010). Thus, neither past history ($\delta_j$ = 0) nor past distribution ( $\beta_j$ = 0) should affect the probability of a price change. The partial price adjustment gap change $\left|P_{w1(t)} -\ P_{w1(t)}{}^*\ \right|$ is not expected to have an impact on the price change in the menu cost theory. In this model, firms will change the price independently of whether the price–cost gap is an increase or a decrease; hence, prices are changed symmetrically. The political business cycle and Energy Fund and the lagged price–cost gap are not applicable to the menu cost theory.

[41] The menu costs are fixed costs, as they do not vary with the size of price changes.

**Hypothesis of rational inattention by producers hypothesis in the autoregressive binomial conditional model.** In the information delay hypothesis, inattentive producers do not frequently update their production plan with regular information on the market conditions. In Reis's (2006) theories of information delays and inattentive producers, the history of the probability of price changes is important; thus, a significant $\beta_j$ is expected. In these theories, there is a negative autocorrelation in the probability of changing gasoline prices in the consecutive periods. Periods with high probability of a change in price are followed by periods with a low probability of price change due to delays in information; hence, $\beta_j < 0$. The political business cycle and 'Energy Fund' are not applicable to the inattentive producer hypothesis. There is also a lower probability of a price change in two successive[42] periods; hence, $\delta_j < 0$. Price setters exhibiting rational inattention are not paying attention to any new information; therefore, no conclusion can be drawn from the response of their pricing behavior on new information. Thus, these firms cannot set prices asymmetrically. In addition, the inattentive producer pays more attention to past information, and the coefficient of $|P_{t-1} - P_{t-1}{}^{*}|$ should be positive and significant, indicating that a large price–cost gap in the $t-1$ period will increase the possibility of price change in period *t*. In this hypothesis, no a priori assumption is made for the partial price gap adjustment.

[42] The data used in the ABC models are usually high frequency (daily) data (Douglas & Herrera, 2010, 2014; Russell & Engle, 2005). For lower frequency data (monthly, quarterly), as in the case of Curaçao, this assumption must be interpreted with caution.

Table 5.4

*Tests in the ABC Model for Curaçao*

| Theories/ hypothesis | Autocorrelation $G^{-1}(h_{t-1})$ | History of price changes $x_{t-1}$ | Partial price adjustment gap $\lvert P_{w1(t)} - P_{w1(t)}^{*} \rvert$ | Symmetry | 'Political business cycle' and 'Energy Fund' | $\lvert P_{t-1} - P_{t-1}^{*} \rvert$ | $\lvert P_{t-3} - P_{t-3}^{*} \rvert$ |
|---|---|---|---|---|---|---|---|
| Menu costs | $\beta_j$ =0 (no effect) | $\delta_j = 0$ | No effect | Yes | Not relevant | Not relevant | Not relevant |
| Inattentive producer | $\beta_j < 0$ | $\delta_j < 0$ | ? | Yes | Not relevant | Positive | Positive |
| Political interference | $\beta_j > 0$ | $\delta_j > 0$ | Positive | No | Negative | Not relevant | Negative |

*Notes.*

'?' means indecisive

Source: Douglas and Herrera (2010) and author's compilation.

**The political interference hypothesis in the autoregressive binomial conditional model.** The political interference hypothesis assumes that the probability of gasoline price changes is determined by periods of political interference. The political interference resulted in Taylor TDP (Taylor, 1980) in price regulation and Calvo TDP (Calvo, 1983) in the regulatory capture and the political business cycle. The gasoline prices in the "contract" period remained fixed in this period consistent with Taylor TDP. Hence, the history of the probability is expected to show the periodicity in the price change. The autocorrelation of past probabilities in the consecutive contract periods is positively related to the probability of price change of current contract period; hence, $\beta_j > 0$. Similarly, the probability of the actual price changes in consecutive contract periods is expected to be positively related, $\delta_j > 0$. In addition, the partial price adjustment gap, $\left|P_{w1(t)} - P_{w1(t)}{}^{*}\right|$, which is an indicator of the recovery index of the gasoline price, is expected to be positive related to the price change. A larger recovery index means that a price change is more likely to occur.

A regulatory capture in the gasoline retail market occurred in the period of the Energy Fund. The period of the Energy Fund is that of June 2006–July 2007. A consequence of the regulatory capture was longer periods with fixed prices than the pre-set quarterly/monthly periods. In addition, the political business cycle influenced the price setting for gasoline in the pre-election periods. The pre-election period was set as 6 months prior to the election by Schuknecht (1996). The result of the political business cycle price adjustment was that prices remained fixed for a longer time than the proposed quarterly/monthly periods. Both elements of political interference are expected to be negatively related to the probability of a price change. Another consequence of political interference is asymmetric price behavior. In this case, the

domestic price changes were adjusted with a time lag and were unsynchronized with the international price changes.

**The test on price asymmetry in the autoregressive binomial conditional model.** To measure asymmetry, Davis and Hamilton (2003) proposed the dummy variable $\theta_t$, which takes the value of 1 if $P_t - \ P_t^* \geq 0$ and zero otherwise. They proposed replacing $\omega$ with $\boldsymbol{z}_t$, defined as follows:

$$\boldsymbol{z}_t = [\theta_t, (1-\theta_t), \theta_t\,(P_t - \ P_t^*), -(1-\theta_t)(P_t - \ P_t^*)]'. \quad (5.5)$$

Meanwhile, price symmetry is when $\theta_t = (1-\theta_t)$, or $\theta_t\,(P_t - \ P_t^*) = -(1-\theta_t)(P_t - \ P_t^*)$.

In this study, I propose using only the coefficients $\theta_t, 1-\theta_t$ to measure the asymmetry. I estimate the parameter $\theta 1_t$ for the positive price–cost gap $(P_{t-1} - \ P_{t-1}^*) > 0$ and $\theta 2_t$ for the negative price–cost gap $(P_{t-1} - \ P_{t-1}^*) < 0$. The Wald test for symmetry is the null hypothesis $\theta 1_t = \theta 2_t$. A rejection of the null hypothesis means that the price adjustments are asymmetric.

## 5.4. Data

The period of research covers the years 1990–2012. The observed monthly data consisted of the Gulf Coast conventional gasoline regular spot price free on board (FOB) and the retail prices of unleaded gasoline 95 in Curaçao. The Gulf Coast conventional gasoline spot price is used as a proxy for the acquisition (purchase) price. These gasoline spot prices were obtained from the Energy Information Administration [EIA], March 20, 2013). They are set in US$ per gallon and are converted to cents (¢) per liter. Figures 5.4*a*, *b*, and *c* show the frequencies of the Gulf Coast gasoline price changes and the retail price changes of the gasoline in Curaçao. On the horizontal axis, the sizes of the price adjustments are shown, with a positive number signifying the size of a

price increase and a negative number representing the size of a price decline. Figure 5.4*a* shows that the small Gulf Coast price changes of 1¢ decline, no price change, and 1¢ increase had the highest frequencies. Gulf Coast gasoline prices remained unchanged in 17% of months.

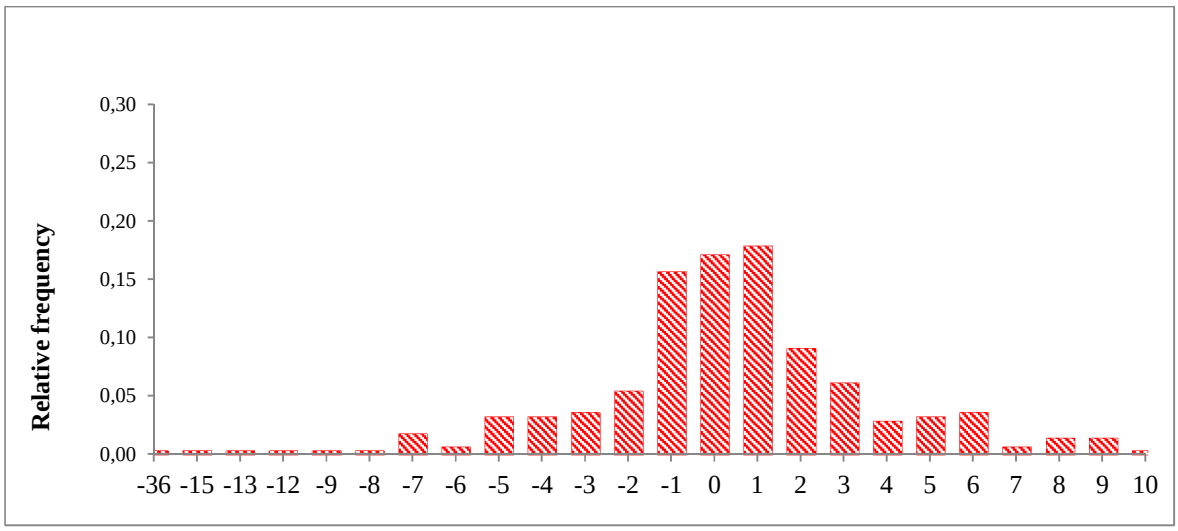


*Figure 5.4a.* The distribution of the Gulf Coast gasoline price change (in US ¢ per liter, January 1990–December 2012). Source: (EIA, 2013)

The retail price of gasoline 95 is regulated at the distribution stage (Stage 2 in Figure 5.1). The monthly unleaded gasoline 95 octane retail price data are available at the website of Curoil (Curoil, 2013). The data provided by Curoil are in Netherlands Antillean guilders, which are converted to US ¢ per liter for comparison with the Gulf Coast gasoline prices. As illustrated in Chapter 2 (Table 2.3), Curaçao's currency is pegged at 1.79 for 1 US $; thus, there is no exchange rate variability in the purchase price of gasoline.

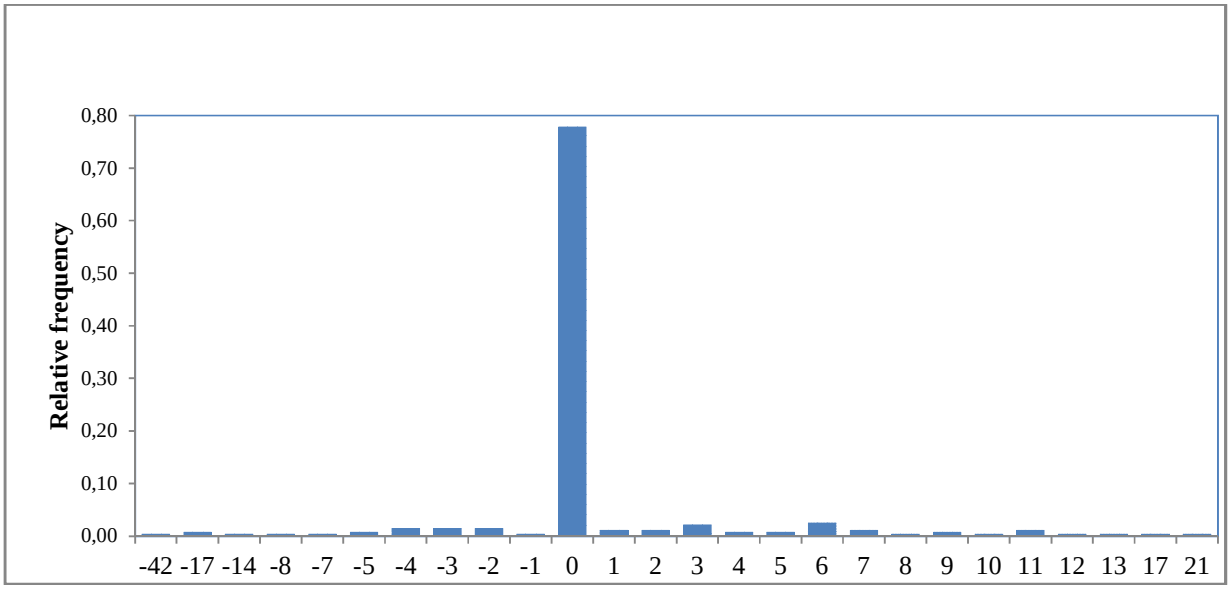


*Figure 5.4b*. The distribution of the monthly gasoline retail price changes in Curaçao (including unchanged prices in January 1990–December 2012). Source: (Curoil, 2013).).

An examination of the distribution of gasoline retail price changes shows a high frequency of unchanged monthly prices (Figure 5.4*b*). Prices were not adjusted in 78% of months in the retail price of gasoline, compared to 17% of months in the Gulf Coast gasoline prices in the period of 1990−2012; which implies that the gasoline prices in Curaçao adjusted asymmetrically and were unchanged for a considerably long period of time when compared to the Gulf Coast prices.

Figure 5.4*c* shows the distribution of sizes of the gasoline price adjustments excluding the unchanged prices. The magnitude of price changes was substantial, varying from a price hike of 21¢ per liter to a price decline of 42¢ per liter.

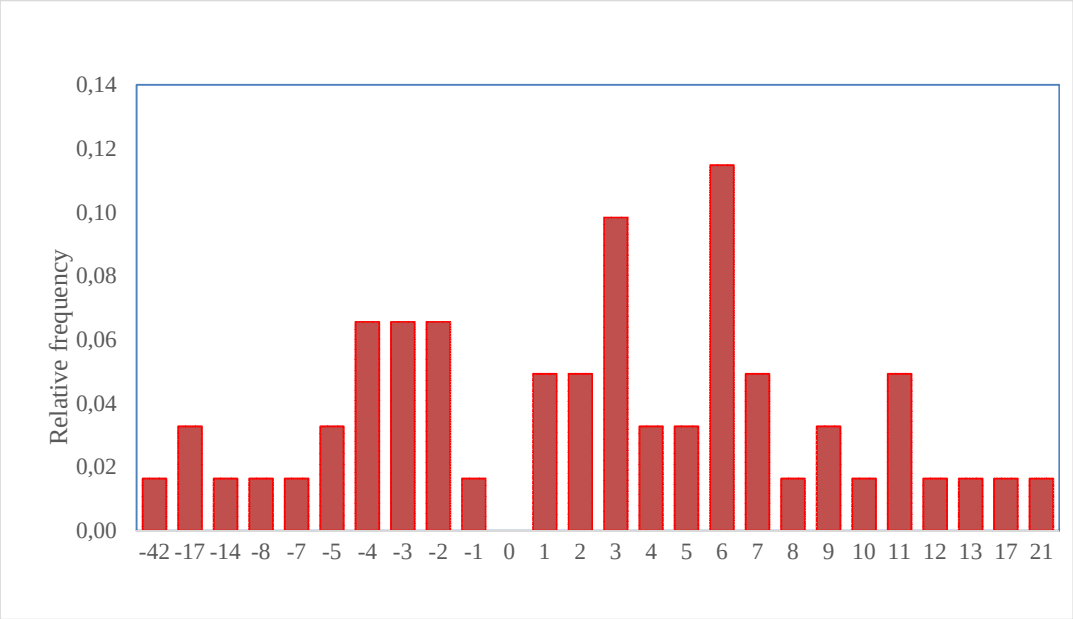


*Figure 5.4c.* Distribution of the monthly gasoline retail price changes in Curaçao (excluding unchanged prices for January 1990–December 2012). Source: (Curoil, March 20, 2013)

The data on political interference include price regulation and the periods of the Energy Fund and the political business cycle. Price regulation is considered according to Taylor TDP and is captured in the data of the price–cost variable $|P_{t-3} - P_{t-3}{}^{*}|$. The cost of gasoline ($P_{t-3}{}^{*}$) is proposed to adjust in the retail price every quarter ($P_{t-3}$). The Taylor TDP of a quarter is chosen because during 1990−2012, the policy of gasoline price adjustment was mainly based on the quarterly price change. Hence, a positive relation on the variable with past information $|P_{t-1} - P_{t-1}{}^{*}|$ in the inattentive producer model is tested with a price–cost gap with a 3 month lag.

The regulatory capture and the political business cycle periods are represented by binary dummy variables. The Energy Fund in the gasoline market was available in 2006 and 2007, when interest groups pressured policymakers to keep the rising energy prices in check. As a result, the regulatory authority collaborated with the government in launching the Energy Fund

in mid-2006. Its purpose was to subsidize the rising oil prices in this period. The Energy Fund remained active from June 2006 to July 2007. Hence, the dummy variable for the regulatory capture is specified by a "1" for this period and "0" otherwise. The second dummy is the political business cycle. Table 5.5 presents the election dates by the two levels of government in Curaçao, namely the central and the island levels. The dummy included a "1" for the 6 months prior to the election. As the sample starts in January 1990, only 3 months prior to the election in March 1990 have a dummy value of "1."

Table 5.5

*Dummies for the Pre elections Period in Curaçao in 1990-2012*

| Elections by level of government | Election date | Dummy =1 for the months of: |
|---|---|---|
| Central Government | 16-Mar-90 | January, 1990−March, 1990 |
| Curaçao Government | 12-Apr-91 | November, 1990−April, 1991 |
| Central Government | 12-Feb-94 | September, 1993−February, 1994 |
| Curaçao Government | 12-May-95 | December, 1994−May, 1995 |
| Central Government | 30-Jan-98 | August, 1997−January, 1998 |
| Curaçao Government | 7-May-99 | December, 1998−May, 1999 |
| Central Government | 12-Jan-02 | August, 2001−January, 2002 |
| Curaçao Government | 9-May-03 | December, 2002−May, 2003 |
| Central Government | 17-Jan-06 | August, 2005−January, 2006 |
| Curaçao Government | 21-Apr-07 | November, 2006−April, 2007 |
| Central Government | 22-Jan-10 | August, 2009−January, 2010 |
| Curaçao Government | 27-Aug-10 | March, 2010−August, 2010 |
| Curaçao Government | 19-Oct-12 | May, 2012−October, 2012 |

*Notes.* Source: Ritter (1995; for 1990–1997), http://kse.cw/ (for 1998–2012).

Political interference has elements of Calvo and Taylor TDP. The price regulation is Taylor TDP and is captured by the data of the price–cost variable. The Calvo pricing is exhibited in the regulatory capture of the Energy Fund and the political business cycle. Calvo pricing is

captured by a joint dummy including both the dummy of the Energy Fund and the dummy of the political business cycle.

## 5.5. Results

The atheoretical logit model, ABC(0,0,0), is the benchmark for the general ABC(*q*,*r*,*s*) models (Douglas &Herrera, 2010). This general ABC(*q*,*r*,*s*) model nests the atheoretical logit model with a predetermined variable $\boldsymbol{z}_t$. In the case of Curaçao, the gasoline prices change every quarter, shifting to every month in mid-2007. It can be expected that lags of 1 and 3 months are significant; hence the most probable lags values of *r* and *s* are 1 or 3. The feasible model versions are summarized in the first column of Table 5.6. The second column is the constant term. In these models, the constant term is estimated in the periods of political interference by regulatory capture and the political business cycle. This is expressed as follows:

$$\text{Let } \boldsymbol{z}_t = (|P_{w1(t-1)} - \ P_{w1(t-1)}{}^*|, |P_{(t-3)} - \ P_{(t-3)}{}^*|, dummypolitical). \tag{5.6}$$

$|P_{w1(t)} - \ P_{w1(t)}{}^*|$ is the recovery index, while $P_{t-3}$ is the monthly gasoline retail price in US ¢ per liter with a lag of 3 months. $P_{t-3}{}^*$ is the monthly acquisition price, which is the Gulf Coast conventional spot oil price in cents per liter lagged by 3 months. Moreover, the variable *dummypolitical* is the Calvo pricing, represented by the joint dummy of the Energy Fund and the political business cycle.

The variable *dummypolitical* in the predetermined $\boldsymbol{z}_t$ variable is equal to constant ω in the periods of political interference. In the periods without political interference, *dummypolitical*=0 and the constant equals zero.

The third and fourth columns show which of the coefficients $\beta_j \ \ and \ \delta_j$ can be estimated and show the assumptions of these coefficients. Column 5 contains the components of a predetermined $\boldsymbol{z}_t$variable, which are the partial price–cost adjustment gap, the absolute price–

cost gap lagged 3 months, and the dummy for political interference. The current absolute price gap, as proposed by Douglas and Herrera (2010), is not included because the price-setting behavior is more likely to have a lag of 1 or 3 months. It is more probably that the absolute price–cost with a lag of 3 months, ($|P_{(t-3)} - P_{(t-3)}{}^{*}|$), will be significant, as prices were proposed to change quarterly.

Table 5.6

*Specifications of the ABC models and the Nested ABC(0,0,0) Models*

| ABC(*0,r,s*) | **ω** | $\beta_j$ | $\delta_j$ | ABC(0,0,0) with $\boldsymbol{z}_t$ |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| ABC(0,0,1) | yes, if *dummypolitical*=1 | $\beta_j = 0$ | $\delta_1$ | $\boldsymbol{z}_t = (\|P_{w1(t-1)} - P_{w1(t-1)}{}^{*}\|, \|P_{(t-3)} - P_{(t-3)}{}^{*}\|$,dummypolitical) |
| ABC(0,1,0) | yes, if *dummypolitical*=1 | $\beta_1$ | $\delta_1 = 0$ | $\boldsymbol{z}_t = (\|P_{w1(t-1)} - P_{w1(t-1)}{}^{*}\|, \|P_{(t-3)} - P_{(t-3)}{}^{*}\|$,dummypolitical) |
| ABC(0,1,1) | yes, if *dummypolitical*=1 | $\beta_1$ | $\delta_1$ | $\boldsymbol{z}_t = (\|P_{w1(t-1)} - P_{w1(t-1)}{}^{*}\|, \|P_{(t-3)} - P_{(t-3)}{}^{*}\|$,dummypolitical) |
| ABC(0,0,3) | yes, if *dummypolitical*=1 | $\beta_j = 0$ | $\delta_3$ | $\boldsymbol{z}_t = (\|P_{w1(t-1)} - P_{w1(t-1)}{}^{*}\|, \|P_{(t-3)} - P_{(t-3)}{}^{*}\|$,dummypolitical) |
| ABC(0,3,0) | yes, if *dummypolitical*=1 | $\beta_3$ | $\delta_j = 0$ | $\boldsymbol{z}_t = (\|P_{w1(t-1)} - P_{w1(t-1)}{}^{*}\|, \|P_{(t-3)} - P_{(t-3)}{}^{*}\|$,dummypolitical) |
| ABC(0,1,3) | yes, if *dummypolitical*=1 | $\beta_1$ | $\delta_3$ | $\boldsymbol{z}_t = (\|P_{w1(t-1)} - P_{w1(t-1)}{}^{*}\|, \|P_{(t-3)} - P_{(t-3)}{}^{*}\|$,dummypolitical) |
| ABC(0,3,1) | yes, if *dummypolitical*=1 | $\beta_3$ | $\delta_1$ | $\boldsymbol{z}_t = (\|P_{w1(t-1)} - P_{w1(t-1)}{}^{*}\|, \|P_{(t-3)} - P_{(t-3)}{}^{*}\|$,dummypolitical |
| ABC(0,3,3) | yes, if *dummypolitica*l=1 | $\beta_3$ | $\delta_3$ | $\boldsymbol{z}_t = (\|P_{w1(t-1)} - P_{w1(t-1)}{}^{*}\|, \|P_{(t-3)} - P_{(t-3)}{}^{*}\|$,dummypolitical) |

*Note.*
The variable ω is equal to the coefficient of the dummypolitical, when the dummypolitical=1, otherwise the variable is equal to 0.

Table 5.7 shows the results of these models in the periods of political interference according to the Calvo TDP. In the first column, all of the model options are presented. The coefficients of Calvo TDP (*dummypolitical*) in the second column were significant at (1%, 5%,

10% significance levels) in all models, and all have the correct signs. The periods of pre-elections and the Energy Fund had a negative impact on the probability of a price change.

Table 5.7

*The ABC Models in the Periods with Political Interference by Calvo Gasoline Pricing (MLE, January 1990–December 2012)*

| ABC(*0,r,s*) | Dummy Political | $\beta_j$ | $\delta_j$ | $\lvert P_{w1(t)} - P_{w1(t)}^{*} \rvert$ | $\lvert P_{t-3} - P_{t-3}^{*} \rvert$ | Log L | LR |
|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| ABC(0,0,1) | –0.94 *** | | 0.08 | 0.11*** | –0.11*** | –157.24 | 0.82 |
| ABC(0,1,0) | –0.70** | 0.55*** | | 0.09*** | –0.06*** | –152.29 | 0.00*** |
| ABC(0,1,1) | –0.63* | 0.52*** | –0.05 | 0.08*** | –0.06*** | –152.67 | 0.00*** |
| ABC(0,0,3) | –1.07 *** | | 0.70** | 0.09*** | –0.11*** | –154.87 | 0.02** |
| ABC(0,3,0) | –0.77 *** | 0.78*** | | 0.09*** | –0.04*** | –135.09 | 0.00*** |
| ABC(0,1,3) | –0.82** | 0.39** | 0.76** | 0.07*** | –0.08*** | –152.05 | 0.01*** |
| ABC(0,3,1) | –0.61** | 0.78** | 0.19 | 0.09*** | –0.05*** | –139.73 | 0.00*** |
| ABC(0,3,3) | –1.17 *** | 0.79*** | 0.53* | 0.06** | –0.04*** | –129.34 | 0.00*** |

*Notes.*

The number of asterisks indicate levels of significance: *** significant at 1%, ** at 5%,* at 10%. In addition, *j* refers to the lags *q*, *r*, and *s* in the ABC(*q*,*r*,*s*) model. The LR reports the *p*-value of the likelihood ratio test the ABC(*q*,*r*,*s*) model to be reduced to the ABC(0,0,0) with $\boldsymbol{z}_t = (|P_{w1(t-1)} - P_{w1(t-1)}^{*}|, |P_{(t-3)} - P_{(t-3)}^{*}|$,dummypolitical).

The coefficient in the third column, $\beta_j$, is the autocorrelation with past probability $G^{-1}(h_{t-1})$. The coefficients of past probabilities were significant in all models at the 1% or 5% significance level. The coefficients of the history of the actual price change variable, $\delta_j$, reported in the fourth column, were significant in the models with a 3 month lag and not significant in the models with a 1 month lag. This is probably related to the relatively higher number of observations with quarterly price adjustment (in the January 1990–June 2007 period) compared to the monthly price adjustment (July 2007–December 2012). The coefficients of variables of the partial price adjustment, $|P_{w1(t)} - P_{w1(t)}^{*}|$, representing the policy of the recovery

index premium in the TDP in Curaçao, and the price–cost gap, $|P_{t-3} - P_{t-3}^{*}|$, the variable representing the Taylor time-dependent price regulation in the fifth and sixth columns, respectively, were significant at 1% in all models except the ABC(0,3,3) model. Here, the partial price adjustment variable (representing the recovery index) was significant at the 5% level. Hence, both the Taylor and Calvo TDP models in the gasoline markets were supported.

The log likelihood reports the value of the logarithm of the probability of the model, and the last column shows the *p*-value of the likelihood ratio (LR) test. A better fit of the ABC(*q*,*r*,*s*) with a predetermined $\boldsymbol{z}_t$ is established when the LR test rejects the ABC(0,0,0) model in favor of the ABC(*q*,*r*,*s*). The first model, ABC(0,0,1), includes the 1 month lagged actual price change variable. Its coefficient, $\delta_1$, is not significant. The *p*-value of the LR test (in the last column) shows that the "atheoretical" model ABC(0,0,0) did not improve with the addition of the 1 month lagged actual price change variable. Hence, there is no difference in the ABC(0,0,0) model and ABC(0,0,1). The *p*-values of the LR tests (the last column) reject the atheoretical ABC(0,0,0) model in favor of all ABC(*0*,*r*,*s*) models, except for ABC(0,0,1).

In Appendix 5 (Table 5A), more nested models are compared and analyzed. In the models of a monthly lag in the history of probabilities of price changes, the model version of ABC(0,1,0) is preferred to ABC(0,1,1); hence, this model version offers the better fit. In the model versions with a 3 month lag in the history of price changes, the model of ABC(0,3,0) is preferred to ABC(0,3,1), and model version ABC(0,3,3) is preferred to ABC(0,3,0). Hence, ABC(0,3,3) provides the best fit in the nested models with a 3 month lagged history of the probability of price changes.

### 5.5.1. The Menu Costs Hypothesis in Curaçao

The *menu costs* were tested by $\beta_j = \delta_j = 0$. This test can be best performed in a model that includes both variables of the lagged price changes and the past distribution of price changes, namely the models ABC(0,1,1), ABC(0,3,1), ABC(0,1,3), and ABC(0,3,3). In these models, the Wald test is applied, and the null hypothesis is $\beta_j = \delta_j = 0$. The null hypothesis was rejected in all of these models. The menu costs model is not applicable to the gasoline market in Curaçao.

### 5.5.2. The Rational Inattention Hypothesis in Curaçao

The test on *the rational inattention* is when $\beta_j < 0, \delta_j < 0$, and the coefficient of the variable $|P_{t-3} - P_{t-3}{}^*|$ is positive. The test was performed on the models ABC(0,1,1), ABC(0,3,1), ABC(0,1,3), and ABC(0,3,3). The coefficient of $|P_{t-3} - P_{t-3}{}^*|$ is negative and significant in all models, and $\beta_j > 0, \delta_j > 0$; hence, the data did not support the theory of rational inattention.

### 5.5.3. The Political Interference Hypothesis in Curaçao

The *political interference hypothesis* requires a significant and positive price–cost change, $|P_{w1(t)} - P_{w1(t)}{}^*|$, and a negative coefficient for political interference measured by the *dummypolitical variable*. The conditions for the political interference hypothesis also include that $\beta_j > 0, \delta_j > 0$; hence, they entail positive autocorrelation of past probabilities in consecutive contract periods and a positive relationship between the probability of price changes and the past price change. The coefficients of the variables of the partial price adjustment and the *dummypolitical* are significant and have the correct signs in all models. The model versions used to test the hypothesis are ABC(0,1,1), ABC(0,1,3), ABC(0,3,1), and ABC(0,3,3). Except

for model ABC(0,1,1) where the coefficient $\delta_j$ did not have the correct sign, all models supported the political hypothesis.

To test the robustness of the *dummypolitical* variable, I used the LR test. The log likelihood in the second column of Table 5.7 includes the *dummypolitical* variable in the model, and the third column excludes the *dummypolitical* variable. The fourth column shows the result of the LR test defined as –2 [LR(unrestricted) – LR (restricted)]. The LR test has a Chi-squared distribution with 1 degree of freedom ( $\chi_1^2$). The models with *dummypolitical* all reject the null of *dummypolitical*=0 at a 1% significance level. The models including the *dummypolitical* variable offered better explanation of the data. The political interference hypothesis was not rejected in the gasoline market of Curaçao.

Table 5.8

*Likelihood Ratio Tests on the Variable Dummypolitical (January 1990−December 2010)*

| Model | Log L including the dummy | Log L without the dummy | Likelihood ratio |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| ABC(0,0,1) | –157.24 | –162.3 | 10.12*** |
| ABC(0,1,0) | –152.29 | –161.7 | 18.82*** |
| ABC(0,1,1) | –152.67 | –162.0 | 18.66*** |
| ABC(0,0,3) | –154.87 | –161.0 | 12.26*** |
| ABC(0,3,0) | –135.09 | –158.0 | 45.82*** |
| ABC(0,1,3) | –152.05 | –160.5 | 16.90*** |
| ABC(0,3,1) | –139.73 | –156.0 | 32.54*** |
| ABC(0,3,3) | –129.34 | –148.1 | 37.52*** |

*Notes.*
$\chi_1^2$ =3.84 at 5% significance level (**),$\chi_1^2$ =6.03 at 1% significance level (***).

### 5.5.4. Price Asymmetry

The analyses in Sections 5.2.4 and 5.3 point to price asymmetry in the gasoline retail market in Curaçao. The test on price asymmetry considers the variable of the price–cost gap, $|P_{t-3} - P_{t-3}^{*}|$. Thus, the test determines whether the coefficient of a positive gasoline price–cost gap ( $P_{t-3}^{*} - P_{t-3}^{*} \geq 0$ ) is equal to that of a negative price–cost gap ( $P_{t-3}^{*} - P_{t-3}^{*} < 0$). The results are presented in in Columns 4 and 5 of Table 5.9.

Table 5.9 shows that the coefficients of positive price cost gap variable, $\theta 1_t$ , and of the negative price–cost gap variable, $\theta 2_t$, are both significant and have opposite signs. The Wald test (in Column 9) is applied to test for symmetry in the price adjustment. The *p*-values of the Wald test show that the symmetry was rejected in all models and prices were asymmetric. A price increase had a negative impact, while a price decline had a positive effect on the probability of price change.

All ABC models, excluding ABC(0,1,1) supported the political interference hypothesis, while the menu cost and the rational inattention of producers hypotheses were rejected in all models. In addition, price asymmetry in the gasoline prices of Curaçao was established. The resulting costs of economic distortion must be calculated in further study.

Table 5.9

*Test on Price Symmetry in the ABC Models and during the Period of Political Interference by Calvo Pricing (January 1990–December 2012)*

| ABC(*0,r,s*) | $\beta_j$ | $\delta_j$ | $\theta 1_t$ | $\theta 2_t$ | Political dummy | $\lvert P_{w1(t)} - P_{w1(t)}^{*} \rvert$ | Log L | Wald test $\theta 1_t = \theta 2_t$ |
|---|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| ABC(0,0,1) | | 0.06 | –0.07*** | 0.13*** | –0.95*** | 0.09*** | –155.74 | 0.000*** |
| ABC(0,1,0) | 0.59*** | | –0.04** | 0.05 | –0.51 | 0.06*** | –154.9 | 0.0001*** |
| ABC(0,1,1) | 0.56*** | –0.06 | –0.04** | 0.06** | –0.61 * | 0.07*** | –155.2 | 0.002*** |
| ABC(0,0,3) | | 0.69** | –0.08*** | 0.13*** | –1.07*** | 0.08*** | –155.7 | 0.000*** |
| ABC(0,3,0) | 0.81*** | | –0.03* | 0.03 | –0.397** | 0.08*** | –139.7 | 0.0059*** |
| ABC(0,1,3) | 0.42** | 0.75** | –0.06*** | 0.08*** | –0.78** | 0.06** | –153.5 | 0.000*** |
| ABC(0,3,1) | 0.79*** | 0.13 | –0.04** | 0.04 | –0.86*** | 0.08*** | –142.6 | 0.0022*** |
| ABC(0,3,3) | 0.76*** | 0.47 | –0.04** | 0.04 | –1.04*** | 0.06** | –140.7 | 0.004*** |

*Notes*.

The number of asterisks indicate levels of significance:*** significant at 1%, ** at 5%,* at 10%; *j* refers to the lags *q*, *r* and *s* in the ABC(*q*,*r*,*s*) model.

The Wald test reports the *p*-value on the test of the null $\theta 1_t = \theta 2_t$

## 5.6. Conclusions

The objective of this chapter was to identify the causes of the sticky gasoline prices in Curaçao. Besides stickiness, domestic gasoline prices were not synchronized with the international gasoline prices in the period of 1990– 2012, as the domestic gasoline retail prices were not adjusted in 78% of months, contrasting to 17% of months of international gasoline price freezes. Moreover, the test on price asymmetry showed that occasional international gasoline price declines, in contrast to frequent increases, were often passed through in the domestic gasoline prices. This indicates a case of inverse "rockets and feathers." Using the ABC model, the hypotheses of political interference, menu costs, and information delay due to inattentive producers were tested with the aim of establishing the causes of price rigidity in the gasoline retail market in Curaçao. The menu costs and information delay by inattentive producers hypotheses were not supported as causes of price rigidity in the gasoline retail market of Curaçao. Political interference in price setting, in contrast—with the gasoline price regulation, periods of pre-elections, and regulatory capture by the Energy Fund—was supported as a cause of gasoline price rigidity. Price regulation in the gasoline retail market in Curaçao was supported in all models. The political interference hypothesis consisted of two price strategies—the political business cycle and regulatory capture; these were supported by all models except one, which was not one of the best models.

The policy of price regulation is consistent with Taylor TDP. The regular duration of price spells in the gasoline retail market was extended with price freezes up to 25 months, which is consistent with Calvo TDP. Hence, both the Calvo and Taylor TDP hypotheses were supported. This outcome presents (one of) the causes of sticky prices in the gasoline retail market. Sticky prices in the gasoline market affect the price change frequencies in most

commodity markets in Curaçao. First, the gasoline price is a driver in the price setting of most commodities. The sticky gasoline prices, consequently lowered the price frequency adjustment in most commodities. Second, as the gasoline market is a segment of the commodity markets, the sticky prices in the gasoline market represent a piece of the price-rigidity puzzle in Curaçao. Hence, the determinants of price rigidity in the gasoline market unraveled a piece of the larger price-rigidity problem in Curaçao.

As was expected, political interference caused economic distortion for the economic agents. In the case of the Energy Fund, the consumers paid a fixed gasoline price in the 2006–2007 period, while international gasoline prices skyrocketed. Consequently, the consumers benefited from the fixed gasoline prices in this period. As the Energy Fund was financed by government loans among other things (NRC- Handelsblad, 2012), this could imply a future taxation to pay back the loans. Hence, the international gasoline price increases that were financed through the Energy Fund will ultimately be paid by the taxpayer.

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Appendix 5: The ABC Model Testing

Table 5A compares the nested model versions. The first two columns show the model versions. The model version in Column 1 is compared with a nested model version in Column 2. In the first eight rows of Table 5A, each ABC model version (in Column 1) is compared to the atheoretical ABC(0,0,0) model version (in Column 2). Column 3 shows the *p*-value of the null hypothesis, and the null hypotheses are stated in Column 4. When a coefficient is insignificant ($p > 0.10$), this means that the model version excluding this coefficient is preferred. The model ABC(0,0,1) is nested in the model ABC(0,0,0). In the case of the ABC(0,0,1) model, the null hypothesis of $\delta_1=0$ was not rejected, and the coefficient of the actual price change was not significant. Hence, the test shows that ABC(0,0,1) does not provide a better fit to the data than ABC(0,0,0). All of the other model versions provide a better fit to the data than the atheoretical model version of ABC(0,0,0).

Table 5A
*The p-Values of the WALD Tests in the ABC Models in the period of Political Interference (January 1990–December 2012)*

| Model version | Compared to | *p*-value | Test |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| ABC(0,0,1) | ABC(0,0,0) | 0.82 | $\delta_1$=0 |
| ABC(0,1,0) | ABC(0,0,0) | 0.00*** | $\beta_1$=0 |
| ABC(0,1,1) | ABC(0,0,0) | 0.00*** | $\beta_1 = \delta_1$=0 |
| ABC(0,0,3) | ABC(0,0,0) | 0.02** | $\delta_3$=0 |
| ABC(0,3,0) | ABC(0,0,0) | 0.00*** | $\beta_3$=0 |
| ABC(0,1,3) | ABC(0,0,0) | 0.01** | $\beta_1 = \delta_3$=0 |
| ABC(0,3,1) | ABC(0,0,0) | 0.00*** | $\beta_3 = \delta_1$=0 |
| ABC(0,3,3) | ABC(0,0,0) | 0.00*** | $\beta_3 = \delta_3$=0 |
| ABC(0,1,1) | ABC(0,1,0) | 0.89 | $\delta_1$=0 |
| ABC(0,1,1) | ABC(0,0,1) | 0.00*** | $\beta_1$=0 |
| ABC(0,1,3) | ABC(0,1,0 | 0.01** | $\delta_3$=0 |
| ABC(0,1,3) | ABC(0,0,3) | 0.02** | $\beta_1$=0 |
| ABC(0,3,1) | ABC(0,3,0) | 0.60 | $\delta_1$=0 |
| ABC(0,3,1) | ABC(0,0,1) | 0.00*** | $\beta_3$=0 |
| ABC(0,3,3) | ABC(0,3,0) | 0.09* | $\delta_3$=0 |
| ABC(0,3,3) | ABC(0,0,3) | 0.00*** | $\beta_3$=0 |

*Notes.*
The number of asterisks indicate levels of significance:*** significant at 1%, ** at 5%,* at 10%.

Following the comparison with the ABC(0,0,0) model, the model versions in Column 1 are compared with other nested model versions. The results show that model ABC(0,1,0) is preferred to ABC(0,1,1), model ABC(0,3,0) is preferred to ABC(0,3,1), and model ABC(0,3,3) is preferred to ABC(0,3,0).

Table 5B shows the result of the ABC models, including a constant and a political dummy. The results show that the political dummy, representing Calvo pricing, and the price–cost gap, representing Taylor pricing, were insignificant in all model versions.

Table 5B

*The ABC Models of Political Dummy with a Constant (MLE, January 1990–December 2012)*

| ABC(*0*,*r*,*s*) | ω | Political dummy | $\beta_j$ | $\delta_j$ | $\lvert P_{w1(t)} - P_{w1(t)}^{*} \rvert$ | $\lvert P_{t-3} - P_{t-3}^{*} \rvert$ | Log L |
|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| ABC(0,0,1) | -2.44*** | -0.09 | | 0.60 | 0.23*** | 0.02 | -122.20 |
| ABC(0,1,0) | -1.61*** | -0.22 | 0.39 | | 0.19*** | 0.01 | -122.96 |
| ABC(0,1,1) | -1.72*** | -0.24 | 0.27 | -0.38 | 0.18*** | 0.01 | -121.54 |
| ABC(0,0,3) | -2.58*** | -0.39 | | 1.41*** | 0.22*** | 0.02 | -115.50 |
| ABC(0,3,0) | -1.59*** | -0.41 | 0.33*** | | 0.20*** | 0.03 | -129.34 |
| ABC(0,1,3) | -2.15*** | -0.37 | 0.18 | 1.36*** | 0.020*** | 0.01 | -114.65 |
| ABC(0,3,1) | -1.72*** | -0.35 | 0.36** | 0.38 | 0.21*** | 0.01 | -118.50 |
| ABC(0,3,3) | -1.91*** | -0.41 | 0.30* | 1.02** | 0.18*** | 0.02 | -113.51 |

*Notes.*

The number of asterisks indicate levels of significance:*** significant at 1%, ** at 5%,* at 10%; *j* refers to the lags *q*, *r*, and *s* in the ABC(*q*,*r*,*s*) model with $\boldsymbol{z}_t = (|P_{w1(t-1)} - P_{w1(t-1)}^{*}|, |P_{(t-3)} - P_{(t-3)}^{*}|$,dummypolitical, ω).

Table 5C shows the results of the two separate dummy components of Calvo TDP, the Energy Fund and the political business cycle, and the constant. The results show that the two separate dummies were not significant when a constant was also included. The price–cost gap variable, representing price regulation, was not significant either.

Table 5C

*The ABC Models of Dummy Election, Dummy Energy Fund and a Constant (MLE, in 1990.01 –2012.12*

| ABC(*0,r,s*) | ω | Political interference dummy | | $\beta_j$ | $\delta_j$ | $\lvert P_{w1(t)} - P_{w1(t)}^{*} \rvert$ | $P_{t-3} - P_{t-3}^{*}\rvert$ | Log L |
|---|---|---|---|---|---|---|---|---|
| | | Election dummy | Energy Fund dummy | | | | | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| ABC(0,0,1) | –2.41*** | 0.08 | –1.63 | | 0.51 | 0.24*** | 0.02 | –120.63 |
| ABC(0,1,0) | −1.63*** | 0.08 | –1.31 | 0.39 | | 0.19*** | 0.01 | –121.98 |
| ABC(0,1,1) | –1.79*** | 0.01 | –1.24 | 0.23 | 0.34 | 0.19*** | 0.01 | –120.49 |
| ABC(0,0,3) | –2.59*** | –0.15 | –1.27 | | 1.32*** | 0.22*** | 0.02 | –115.05 |
| ABC(0,3,0) | –1.87*** | 0.05 | –1.40 | 0.28 | | 0.22*** | –0.02 | –119.04 |
| ABC(0,1,3) | –2.22*** | –0.18 | –1.04 | 0.15 | 1.28*** | 0.21*** | –0.01 | –114.39 |
| ABC(0,3,1) | –1.95*** | 0.011 | –1.31 | 0.26 | 0.37 | 0.22*** | –0.02 | –118.49 |
| ABC(0,3,3) | –2.18*** | –0.14 | –1.107 | 0.19 | 1.06*** | 0.020*** | –0.02 | –114.03 |

*Notes.*

The number of asterisks indicate levels of significance: *** significant at 1%, ** at 5%,* at 10%; *j* refers to the lags *q*, *r*, and *s* in the ABC(*q*,*r*,*s*) model t with $\boldsymbol{z}_t = (, |P_{w1(t-1)} - P_{w1(t-1)}^{*}| , |P_{(t-3)} - P_{(t-3)}^{*}|$, dummyelection, dummyenergy, ω).

Table 5D

*The ABC Models of Dummy Election and a Constant (MLE, January 1990−December 2012)*

| ABC(*0*,*r*,*s*) | ω | Political interference dummy Election dummy | $\beta_j$ | $\delta_j$ | $\lvert P_{w1(t)} - P_{w1(t)}{}^{*} \rvert$ | $P_{t-3} - P_{t-3}{}^{*} \rvert$ | Log L |
|---|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| ABC(0,0,1) | -2.46*** | 0.02 | | 0.61 | 0.23*** | 0.02 | -122.23 |
| ABC(0,1,0) | -0.30* | -0.22 | 0.78** | | 0.07*** | -0.02 | -132.78 |
| ABC(0,1,1) | -1.94*** | -0.00 | 0.19 | 0.46 | 0.19*** | 0.01 | -122.03 |
| ABC(0,0,3) | -2.63*** | -0.20 | | 1.40*** | 0.22*** | 0.02 | -115.93 |
| ABC(0,3,0) | -1.89*** | -0.00 | 0.30* | | 0.21*** | 0.02 | -120.82 |
| ABC(0,1,3) | -2.25*** | -0.23 | 0.16 | 1.36*** | 0.19*** | 0.01 | -115.16 |
| ABC(0,3,1) | -1.97*** | -0.04 | 0.27 | 0.44 | 0.21*** | 0.02 | -119.97 |
| ABC(0,3,3) | -2.20*** | -0.18 | 0.21 | 1.13*** | 0.19*** | 0.02 | -114.80 |

*Notes.*

The number of asterisks indicate levels of significance: *** significant at 1%, ** at 5%,* at 10%; *j* refers to the lags *q*, *r*, and *s* in the ABC(*q*,*r*,*s*) model with $\boldsymbol{z}_t = (, \lvert P_{w1(t-1)} - P_{w1(t-1)}{}^{*} \rvert , \lvert P_{(t-3)} - P_{(t-3)}{}^{*} \rvert$, dummyelection, ω).

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Table 5D shows the ABC models with both a constant and the variable of the dummy election. The results show that the dummy election and the price–cost gap variable were not significant in any models. The constant in the ABC models can be considered an average between the period without political interference and the period with political interference. As my focus is on the period with political interference, only this period was considered; the results have been presented in the main text.

# CHAPTER 6

# DOES THE PURCHASING-POWER PARITY (PPP) HYPOTHESIS HOLD ON THE CARIBBEAN MICRO-ISLANDS?

The PPP hypothesis postulates a bilateral relationship between the exchange rate of trading countries and their relative prices. The PPP has two versions—the absolute PPP and the relative PPP. The absolute version posits that the national price levels should be equal when expressed in a common currency. The relative PPP hypothesis assumes that the difference between the percentage price changes of the two trading countries equals the percentage change of their exchange rate. Both PPP versions are based on the three following assumptions: (a) the law of one price (LOP), (b) the existence of a frictionless arbitrage mechanism, and (c) a constant real exchange rate (RER).

The PPP has two practical applications in the international trade, which are the settings of exchange rate parities and the measurement of the degree of nominal exchange rate misalignments. Rejection of the PPP hypothesis, therefore, implies that the theoretical foundation of existing exchange rate alignments is unjustified. Despite a considerable amount of research dedicated to this subject since the 1990s, the empirical evidence on the absolute and relative PPP hypotheses remains ambiguous; weak empirical support for the PPP hypotheses has obtained (Rogoff, 1996, Taylor & Taylor, 2004). The most mentioned causes of the departure from the PPP hypotheses are as follows: the inclusion of non-tradable goods, differences in reporting of the national statistical agencies, the arbitrage costs (e.g., transaction costs), and imperfect competition in trade (Krugman & Obstfeld, 2000, p. 414). The Balassa–Samuelson

effect[43] and sticky prices are also mentioned to lead to failure of the PPP hypothesis. According to Rogoff (1996), "the failure of the short-run PPP can be attributed in part to stickiness in nominal prices; as financial and monetary shocks buffet the nominal exchange rate, the real exchange rate also changes in the short run" (p. 654).

The Caribbean micro-islands have comparatively high transportation costs. Such costs lead to relatively higher prices for Caribbean micro-islands compared to larger countries. Thus, the law of one price, and consequently the PPP hypotheses, will be less likely to hold. In addition, the sticky prices reported in Curaçao in the period of 2006 to 2010 may lead to a deviation from the PPP hypothesis. As the high transportation costs in the Caribbean micro-islands and the sticky prices in Curaçao may cause a departure from PPP hypotheses, it is interesting to examine whether the PPP hypotheses hold in Caribbean micro-islands.

The objective of this chapter is to examine the validity of the PPP hypotheses on the Caribbean micro-islands, particularly Curaçao. Here, the PPP hypotheses are tested for selected Caribbean micro-islands in the period of 1990–2012. The selection is based on data availability and includes Aruba, the Bahamas, Barbados, Curaçao, Dominica, Saint Kitts and Nevis, and Saint Lucia.

This chapter proceeds in Section 6.1 by providing a literature overview on the derivation and the empirics of the PPP hypotheses. Section 6.2 describes the tests used to validate the two PPP hypotheses. The data description of the CPIs and the RERs of the selected Caribbean micro-islands is presented in Section 6.3. The results show that the absolute PPP does not hold in the selected Caribbean micro-islands. Section 6.4 presents the results of tests to validate the relative

[43] The Balassa–Samuelson effect is when productivity differentials exist between tradable sectors of two countries. These may lead to a departure from the PPP. As no data on productivity are available for Caribbean-micro islands, this factor will not be studied further.

PPP in the selected Caribbean micro-islands. The results reveal that the PPP holds for five out of the seven selected Caribbean micro-islands. Remarkably, the PPP holds for Curaçao, the island with sticky prices. The last section, Section 6.5, presents the conclusions on the impact of the high transportation costs of the selected Caribbean micro-islands and sticky prices in Curaçao on the relative PPP.

## 6.1. The Absolute and Relative PPP Hypotheses

The first assumption says that an "identical" good *i* produced in two different countries has the same price. This relation is assumed to hold for all *N* goods in the economy (Equation (6.1)).

### 6.1.1. Assumption 1: The Law of One Price (LOP)

$$P_t^i = S_t * P_t^{f,i} \qquad i=1,\ldots,N, \tag{6.1}$$

where:

$P_t^i$ : The domestic price of good *i*, at time *t*

$P_t^{f,i}$: The foreign price of good *i*, at time *t*

$S_t$ : The nominal exchange rate of the domestic currency in a unit of foreign currency at time *t*.

By summing the weighted prices of tradable[44] goods, the *absolute* PPP equation is obtained as follows:

$$S_t = \frac{\sum_{i=1}^{N} \alpha_i P_t^i}{\sum_{i=1}^{N} \alpha_i P_t^{f,i}} = \frac{P_t}{P_t^f}, \tag{6.2}$$

where:

$P_t$ : The weighted average domestic price of all goods, at time *t*

$P_t^f$: The weighted average foreign price of all goods at time *t*.

$\alpha_i$: The weights in the summation with $\sum_{i=1}^{N} \alpha_i$=1.

Equation (6.2) can be rewritten as follows:

$$S_t * \frac{P_t^f}{P_t} = 1. \tag{6.3}$$

[44] A tradable good is a good that is traded on the international markets.

The left-hand side of Equation (6.3) is the RER. The *first* test on the validity of the *absolute* PPP hypothesis is whether the RER is equal to 1, or in other words, whether one unit of good *i* costs the same in both countries.

The best-known example applied for the law of one price, is the Big Mac index, which was introduced by *The Economist* in 1986. The Big Mac index is based on prices of McDonald's Big Mac hamburgers by country, which are used in a worldwide price comparison. However, the Big Mac index does not comply with the condition of an identical good, as assumed by the law of one price. Big Macs are not identical[45] among countries due to the differences in the non-tradable input cost component in prices. The differences in the national labor costs in producing a Big Mac (Parsley & Wei, 2004), the differentiation in rents (Taylor & Taylor, 2004), and diversity in tax systems (Pakko & Pollard, 2003) are some examples of non-tradable components in the domestic prices. In addition, Big Mac hamburgers differ by country; for instance, the food is halal in Middle Eastern countries, India substitutes alternatives for beef, and the beef is kosher in Israel. Hence, the law of one price does not apply. Similar to the Big Mac, most goods are not "identically" produced in different countries. Moreover, the weights in the basket of the CPI goods are not the same across countries, as the preferences are country specific. Hence, these differences contradict the first assumption.

### 6.1.2. Assumption 2: Frictionless Trade

The second assumption of a frictionless trade environment guarantees that when the first assumption is violated, arbitrageurs will profit as long as price differentials for the "identical" good exist. The second assumption of the PPP requires continuously well-informed frictionless markets. However, markets are not always well informed (Pippenger, 1986), and trade is not

[45] The "iPad" index is a new but not yet widely accepted index to compare prices worldwide. The advantage of this product is that each version is identical around the world.

frictionless due to arbitrage costs in spatially separated markets. The arbitrage costs include transportation costs, administrative costs, tariffs, and non-tariff trade barriers (e.g., inspection requirements on food imports). The arbitrage costs of tariffs, transportation costs, and insurance were studied in Micheal, Nobay, and Peel (1997) and Sercu, Uppal, and Van Hulle (1995), and the non-tariff barriers were examined in Sarno and Taylor (2002). It can be assumed that the arbitrage costs do not change in the short run, and they are accumulated in a constant factor, Π.

### 6.1.3. Assumption 3: The Constant Real Exchange Rate

$$S_t * \frac{P_t^f}{P_t} = \Pi \,. \qquad (6.4)$$

Hence, the RER on the left-hand side of Equation 6.4 is a constant, which is the third assumption of the PPP and the *second* test on the validity of the *absolute* PPP hypothesis.

### 6.1.4. Absolute and Relative PPP

The third assumption, a constant RER, is frequently used to test the *absolute* PPP hypothesis. The second test has replaced the first test of the absolute PPP, which is that the RER is equal to 1. The test of a constant RER takes into account the existence of arbitrage costs in trade.

The *relative* PPP is obtained by first taking logs of Equation (6.4), as follows:

$$s_t = p_t - p_t^f + \pi, \qquad (6.5)$$

and then by taking the first differences of Equation (6.5):

$$\Delta s_t = \Delta p_t - \Delta p_t^f + \Delta\pi. \qquad (6.6)\,[46]$$

For the *relative* PPP (Equation 6.6) to hold, $\Delta\pi$ has to be equal to zero. Hence, the test on the relative PPP is whether $\Delta\pi = 0$. If $\Delta\pi \neq 0$, Equation (6.6) can be considered as the deviation

[46] The interpretation of Equation (6.6) is that when the relative PPP holds ($\Delta\pi = 0$), then the change in the exchange rate (depreciation/appreciation) is identical to the difference in movements in prices (or the inflation rates) in the two countries. In other words, the exchange rate changes are proportional to the relative inflation. The relative PPP hypothesis, therefore, is an important element in forecasting the exchange rates in exchange rate models.

from the PPP. This equation describes the short-run PPP, while Equation (6.5) represents the long-run PPP. A departure from the PPP hypothesis is allowed in the short run, as deviation is allowed; in the long run, the deviations of the RER are mean-reverting towards the long-run PPP.

### 6.1.5. Fixed-exchange Regimes, Sticky Prices, and the Relative PPP Hypothesis

The Caribbean micro-islands mainly have fixed exchange rates (Chapter 2), implying that $\Delta s_t = 0$ for all goods traded with the anchor country. Using Equation (6.6) for a fixed-exchange rate country, the new equation results in the following:

$$\Delta p_t = \Delta p_t^* + \Delta \pi. \qquad (6.6a)$$

The relative PPP test is whether $\Delta \pi = 0$. If the PPP holds in a fixed-exchange-rate system, Equation (6.6*a*) implies the equality of the inflation rates of the domestic and the anchors' economy, $\Delta p_t = \Delta p_t^*$. When prices are sticky in the short run on a Caribbean micro-island, this may lead to the inequality of $\Delta p_t \neq \Delta p_t^*$. Therefore, sticky prices may cause a deviation from the PPP.

The empirical tests in the literature often apply the relative PPP hypothesis. This hypothesis assumes that the long-run PPP follows a mean reverting process. The linear and nonlinear approaches are the two widely used methods to test the relative PPP. The linear approach is mainly based on co-integration, and the nonlinear approach consists of Markov switching models, the threshold autoregressive (TAR) models, "momentum" TAR (M-TAR or MTAR), and the (exponential) smooth TAR (ESTAR) models.

The linear approach assumes that the adjustment of the RER to its mean-reverting equilibrium is a linear, continuous, one-speed process. In most studies, the linear approach is specified in a log-linear form, as the data have been transformed into logs. However, the tests using the linear approaches have proven to have low power (Sarno & Taylor, 2002; Taylor &

Taylor, 2004). The power of the test is the probability that it will correctly lead to rejection of a false null hypothesis (Greene, 1997). The problem of the low power of the test lies in the use of short time series in the samples to test the mean reversion of the RER, while the process of the mean reversion of the RER is slow (Rogoff, 1996; Sarno, 2003).[47] A slow adjustment of the RER toward the mean implies that a long span of data is necessary to correctly reject the null hypothesis that the PPP hypothesis is false (Sarno & Taylor, 2002).

In the nonlinear specification, the adjustment to the mean-reverting value of the PPP is a nonlinear process that either "jumps/leaps" from one regime to the next or changes "smoothly" between regimes. In contrast to the linear specification, the nonlinear process has more than one speed of adjustment of the RER. The tests of the nonlinear approach of the adjustment of the RER have proven to have more power than linear approach (Balke & Fomby, 1997; Kapetanios, Shin, & Snell, 2003). The latter study shows that the power of the nonlinear test, with the values of 0.183 and 0.488, is higher than that of the linear test, which has values of 0.160 and 0.341 for 50 and 100 observations, respectively. Literature reviews conducted by Sarno (2003, 2005) showed that the process of deviation from PPP is nonlinear, as opposed to the presumed linear specification, with a constant speed of adjustment. His motivation for using a nonlinear specification was that the existence of transaction costs causes a nonlinear adjustment.

In the Markov switching models, the RER switches from stages of appreciation to stages of depreciation and vice versa, or it remains in the same stage. Every switch between the stages has a different conditional distribution (Leon & Najarian, 2005). On the Caribbean micro-islands, this approach is less likely to apply, as most of the islands have a system of long-lasting fixed exchange rates, without stages of devaluation and revaluation (Chapter 2, Table 2.3).

[47] The half-life of deviations from the PPP is 3–5 years.

Obstfeld and Taylor (1997) suggested an arbitrage cost band where, for small price differentials, no adjustment of the RER takes place, and the PPP does not hold. Outside the band, the price differentials exceed the transaction costs, and the adjustment is mean reverting; hence, the PPP holds. Accordingly, the RER leaps in and out of the arbitrage band, and the behavior is asymmetrical. In the three-regime, band-TAR models, the RER leaps in a band of inaction—the area between the threshold values wherein no adjustment takes place. When the RER leaps outside the band, or when it exceeds the threshold, a co-integration relation exists between the nominal exchange rates and the relative prices. The threshold's band is interpreted as the transaction/arbitrage costs in Obstfeld and Taylor (1997, p. 442). The model in their study is applied on selected CPI categories in selected cities in the United States, Canada, Mexico, Europe, and Asia. An application of the three-regime band-TAR models is also found in Leon and Najarian (2005) in some of the 26 developed and emerging market countries. Other theoretical models with three regimes were presented in Balke and Fomby (1997) and Sercu et al. (1995). As data on the transaction costs are not available for the Caribbean micro-islands, and the deviations need to be compared with the transaction costs, the three-regime model will not be applied in this chapter and remains open for further study.

In the two-regime TAR or MTAR models, the threshold is the division between the positive deviations and the negative deviations from the PPP. In these models, the two regimes can have distinct speeds of adjustment. Thus, the method allows for asymmetric adjustments. TAR was applied to a two-regime model for African countries by Chang, Lu, Tang, and Liu (2011), European countries by Enders and Dibooglu (2001), and countries in the Pacific by Enders and Chumrusphonlert (2004). For the African countries, using the United States as a base country, the relative PPP holds when specified by an asymmetric adjustment in 17 out of 22

countries in the period of 1980–2003. Data from all seven European countries in Enders and Dibooglu's (2001) sample supported the long-run PPP with an asymmetric adjustment specification in the period of 1973−1997. In this case, Germany and France were the two base economies. In Enders and Chumrusphonlert (2004), when using Japan as base country, five out of seven countries in the Pacific had a long-run PPP. With the United States as base country, the PPP held for six out of seven Pacific countries for the period of 1973−2001. The adjustments were asymmetric. This overview shows that the TAR models have been applied to both developing and developed countries with considerable support for the PPP hypothesis when using an asymmetric specification.

According to Terasvirta (1994), Micheal et al. (1997), and Taylor and Peel (2000), the speeds of RER adjustment can switch *smoothly* from one "regime" to the next in the ESTAR models. The smooth transition of the ESTAR models portrays the aggregated, unsynchronized behavior of heterogeneous economic agents. An ESTAR model is used when there is a symmetric adjustment of the RER. Kapetanios et al. (2003) showed the symmetric adjustments in bilateral trade between Australia, Germany, France, Italy, New Zealand, and the United Kingdom and United States in the period of 1957−1998. Sarno and Taylor (2002) showed that the ESTAR model is a generalization of the TAR model (see Appendix 6). ESTAR models have mostly been applied to developed countries.

The limited research in the Caribbean area uses the linear approach of the PPP hypothesis in the Eastern Caribbean Currency Union (ECCU). Rambarran (1998) applied the linear co-integration approach to Caribbean countries, including Barbados, Guyana, Jamaica, Trinidad and Tobago, and the ECCU vis-à-vis the US in the period of 1973−1993 and found no evidence for the PPP. The study by Darius and Williams (2000) found weak evidence in the period of

1980−1997, as the PPP held for only two of the six selected countries of the ECCU. They used the linear approach of the unit root test and applied the co-integration method for the relation between the six selected countries of the ECCU and the United States. Aggarwal and Simmons (2004) examined the PPP using the linear approach of co-integration among five selected ECCU countries in the period of 1980–2000 and found that the bilateral PPP relations held among these countries. Sun and Duttagupta (2008) used the linear co-integration approach in the period of 1990−2006 for the bilateral relation between six of the eight ECCU countries and the United States and concluded that the PPP does not hold.

Overall, studies of the Caribbean micro-islands have applied the linear approach to the deviation of the RER. According to the literature (Sarno 2003, 2005), transaction costs motivate the use of a nonlinear specification. Hence, the high transportation costs that are typically found on micro-islands represent a strong motive to apply nonlinear specifications. Moreover, due to the higher power of the test of the nonlinear specification, this specification has strong econometric merits compared to the linear specification. Nonlinear specifications include a smooth (ESTAR) process or an adjustment with a jump (TAR or MTAR). As a priori information on the deviation from the RER on the Caribbean micro-islands is not available, both nonlinear specifications of the TAR/MTAR, and the ESTAR models will be applied to the data.

### 6.2. Tests on the PPP Hypotheses

The absolute and relative PPP may not hold for micro-islands, as their high transportation costs will result in prices that differ from those of their trading partners. Sticky prices on a micro-island may also lead to a rejection of the relative PPP. If the relative PPP is not rejected, the deviations can be presented by either a linear or a nonlinear specification.

### 6.2.1. Tests on the Linear Specification of the Relative PPP

There are two methods of testing the linear approach of the relative PPP. The first test focuses on non-stationarity (a unit root) in the RER. The null hypothesis ($H_0$) posits the non-stationarity of the RER, while the alternative hypothesis ($H_1$) suggests RER stationarity. If it is not possible to reject the unit root behavior of the RER, then it follows a random walk and lacks convergence. This implies a rejection of the PPP hypothesis. The unit root test on the RER is the augmented Dickey–Fuller (ADF) test, and the *t*-test statistic is labeled $t_{ADF1}$.

The second test checks for co-integration between the exchange rate and the relative prices (Mark, 1990; Sarno & Taylor, 2002). The proposed co-integration test is the two-step Engle and Granger (1987) procedure. If the variables are co-integrated, the PPP hypothesis holds. The variables are co-integrated when the errors of the co-integrated equation are stationary. The first step in the procedure is to estimate the long-run equilibrium using OLS. Equation (6.7) is an adapted version of Equation (6.5) when applied to fixed-exchange-rate countries, as follows:

$$f_t = \alpha_0 + \alpha_1 p_t + u_t\,, \tag{6.7}$$

where $f_t = s_t + p_t^f$, and $u_t$ is the stochastic disturbance term, which may be serially correlated.

All variables are expressed in logs. The second step is to estimate the following equation with OLS:

$$\Delta u_t = \rho u_{t-1} + \sum_{i=1}^{l} \gamma_i \Delta u_{t-i} + \varepsilon_t, \tag{6.8}$$

where $\varepsilon_t$ is white noise. If the errors ($u_t$) have a unit root, then they are serially correlated, and OLS is therefore not applicable; thus, the PPP hypothesis is rejected. This linear framework uses the ADF test on the errors with a null hypothesis ($H_0$) of non-stationarity of $u_t$ against the alternative hypothesis ($H_1$) of stationarity of $u_t$. Rejection of $H_0$ means that the PPP hypothesis

holds. The *t*-statistic on the errors is labeled $t_{ADF2}$. The critical values are tabulated in Phillips and Ouliaris (1988).

### 6.2.2. Tests on the Nonlinear Specification of the Relative PPP

The motivation for a nonlinear specification comes from market frictions between two trading countries. The deviations from the PPP follow a nonlinear process that is mean reverting (Sarno & Taylor, 2002). The validity of the PPP hypothesis found firmer empirical grounds through the introduction of the nonlinear specifications of ESTAR (Bahmani-Oskooee, Kutan, & Zhou, 2007; Kapetanios et al., 2003; Sarno, 2005) and TAR (Chang et al., 2011; Enders & Dibooglu, 2001). ESTAR and TAR are discussed below.

**The exponential smooth transition autoregressive model: A two-regime model**. The smooth adjustment toward the long-run PPP is by an ESTAR specification. The ESTAR model has the following form in Kapetanios et al. (2003):

$$\Delta y_t = \sum_{j=1}^{p} \rho_j \Delta y_{t-j} + \gamma y_{t-1}[1 - \exp(-\theta y_{t-1}^2)] + \varepsilon_t, \quad (6.9)$$

where:

$y_t$ : the "de-meaned" or "de-trended" series of the RER; thus, $y_t$ is a mean zero stochastic process

*j:* the lags (*1* to *p*) of serial correlated errors

$\rho_j$: the autoregressive coefficient of lag variable *j*

$\gamma$ : the coefficient of the nonlinear variable or exponential transition function:

$1 - \exp(-\theta y_{t-1}^2)$

$\theta$: the speed of adjustment

$\varepsilon_t$: i.i.d. error with zero mean and constant variance.

The exponential transition function: $[1 - \exp(-\theta y_{t-1}^2)]$ is symmetrical and U-shaped around zero. The adjustment of RER is symmetrical for adjustment above and below the

equilibrium (two regimes). The "de-meaned" series, $y_t$, is obtained by regressing the series of the RER on a constant and saving the residuals. The "de-trended" series is created by regressing on a constant and a trend and saving the residuals. The RER is de-meaned or de-trended to generate a zero mean variable.

A new test for the nonlinear process was introduced by Kapetanios et al. (2003). They included nonlinearity as the alternative hypothesis. Their null hypothesis ($H_0$) was the unit root (as in the ADF tests), and their alternative hypothesis ($H_1$) was a nonlinear stationary process. Thus, the hypothesis is: $H_0$: $\theta = 0$, and $H_1$: $\theta > 0$.

If $\theta = 0$, Equation (6.9) is equal to Equation (6.8). There is no mean reversion when $\theta = 0$, and the process is a linear autoregressive model with a unit root. If $\theta > 0$, it determines the speed of mean reversion (Kapetanios et al., 2003, p. 362). When the speed of adjustment, $\theta$, is small, it has a unit root behavior, which also means a slower transition, $[1 - \exp(-\theta y_{t-1}^2)]$, and more persistence away from PPP. A higher speed of adjustment means a higher transition and smaller deviations in the proximity of PPP.

Because $\gamma$ under the $H_0$ is not known, Kapetanios et al. (2003) used a first-order Taylor series approximation of the exponential function in Equation (6.9), namely $e^{-\theta y^2} = \sum_{n=0}^{\infty} \frac{(-\theta)^n y^{2n}}{n!}$, to obtain Equation (6.10), as follows:

$$\Delta y_t = \sum_{j=1}^{p} \rho_j \Delta y_{t-j} + \delta y_{t-1}^3 - \frac{\delta\theta y_{t-1}^5}{2!} + \frac{\delta\theta^2 y_{t-1}^7}{3!} + \cdots \qquad (6.10)$$

The new hypotheses are $H_0$: $\delta = 0$ and $H_1$: $\delta < 0$. The *t*-statistic of the de-meaned/de-trended nonlinear series is denoted $t_{NL} = \frac{\hat{\delta}}{s.e.(\hat{\delta})}$, where $\hat{\delta}$ is the OLS estimate of Equation (6.10) and s.e. $(\hat{\delta})$ is the standard error of $\hat{\delta}$. The critical values of the $t_{NL}$ statistics were tabulated by Kapetanios et al. (2003, p. 364).

**Threshold autoregression: A two-regime model.** The test for asymmetric adjustment is based on the methodology used by Enders and Siklos (2001). They started by using the two-step procedure (Engle & Granger, 1987). The first step of the procedure is similar to Equation (6.7); the estimation of the long-run equilibrium for fixed-exchange-rate systems is as follows:

$$f_t = \alpha_0 + \alpha_1 p_t + u_t, \tag{6.7}$$

where $f_t = s_t + p_t^f$ and $u_t$ is the stochastic disturbance term.

All variables are expressed in logs. The second step is to estimate the following:

$$\Delta u_t = I_t\, \rho_1 u_{t-1} + (1 - I_t)\rho_2 u_{t-1} + \sum_{i=1}^{l} \gamma_i \Delta u_{t-i} + \varepsilon_t, \tag{6.11}$$

where $\varepsilon_t$ is white noise and $I_t$ is a Heavyside indicator function. This function depends on a threshold value, $\tau$. The Heaviside indicator function is defined by the following:

$$I_t = \begin{cases} 1, & u_{t-1} \geq \tau \\ 0, & u_{t-1} < \tau \end{cases}. \tag{6.12}$$

Then, if the deviation from the PPP exceeds the threshold, $u_{t-1} \geq \tau$, then $I_t$ = 1 and the deviation reverts to $\rho_1$. If $u_{t-1} < \tau$, $I_t$ = 0, the deviation reverts to $\rho_2$ (two regimes). The nonlinear approach, in contrast to the linear specification, allows for the adjustments of the deviations to occur at different speeds, $\rho_1$ and $\rho_2$. The value $\tau$ is estimated using Chan's (1993) method. The statistical package of Eviews (version 7) offers an add-in program, "Tarcoint," to calculate the value of the threshold.

The necessary condition for stationary $u_t$ is -2 < $(\rho_1, \rho_2) < 0$. Under $H_o$: $\rho_1 = \rho_2 = 0$, the test for no co-integration, a non-standard *F* statistic (Enders & Siklos, 2001), is applicable (rejecting $H_o$ means that the variables are co-integrated). The test for symmetric adjustment is $H_o$: $\rho_1 = \rho_2$. This test has a standard *F* distribution. Rejection of $H_o$ means that the speed of adjustment is asymmetric.

In Enders and Siklos (2001) the MTAR was defined using the change in $u_{t-1}$ ($\Delta u_{t-1}$) instead of the level $u_{t-1}$, as follows:

$$M_t = \begin{cases} 1, & \Delta u_{t-1} \geq \tau \\ 0, & \Delta u_{t-1} < \tau \end{cases}. \quad (6.13)$$

Hence, if the change in the deviations from the PPP exceeds the threshold, $\Delta u_{t-1} \geq \tau$, then $M_t$ = 1 and the change of the deviations reverts to $\rho_1$. If $\Delta u_{t-1} < \tau$, $M_t$ = 0 the change in the deviations reverts to $\rho_2$. MTAR is used when the changes of the deviations from the PPP, $\Delta u_t$, are large. According to Enders and Siklos (2001, p. 168), MTAR is applied in cases where policymakers seek to "smooth out" large changes in the series.

### 6.3. The Data

The data that are commonly used to test the PPP hypotheses are the bilateral RER and the multilateral real effective exchange rate (REER). PPP tests using the data of the bilateral RER are found in Chang et al. (2011) and Kapetanios et al. (2003). The multilateral REER is used in Bahmani-Oskooee (1993), Bahmani-Oskooee et al. (2007), and Leon and Najarian (2005). In this chapter, the RER is applied, as the focus is on the bilateral relations between a selection of Caribbean micro-islands and the United States.

The RER is constructed with the exchange rate and prices of the two trading countries. The prices are measured using one of the following price indexes: the CPI (Chang et al., 2011; Kapetanios et al., 2003; Sarno & Valente, 2006), the wholesale price index (WPI; Micheal et al., 1997), or the GDP deflator (Edison & Kloveland, 1987). Each of these price indices has advantages and disadvantages. The advantage of the CPI is that CPI data are available in most countries; however, its disadvantage is that it contains price indices of both tradable and non-tradable goods and services. As the LOP is based on tradable goods and services, the inclusion

of non-tradable goods and services provides a margin of error in the data to test the PPP hypothesis.

Another issue with the use of CPI data in testing the PPP theory is that the CPI does not include the prices of trade in services. Trade in services (e.g., tourism) represents a substantial part of the tradables produced on micro-islands, but this is not measured in the CPI. Moreover, according to McCloskey and Zecher (1984), the price indices used to test the PPP have flaws, and therefore they cannot be applied as evidence for a rejection of the PPP theory. Accordingly, price indices should capture the characteristics of commodities, such as the ease of use or the reliability of the service.

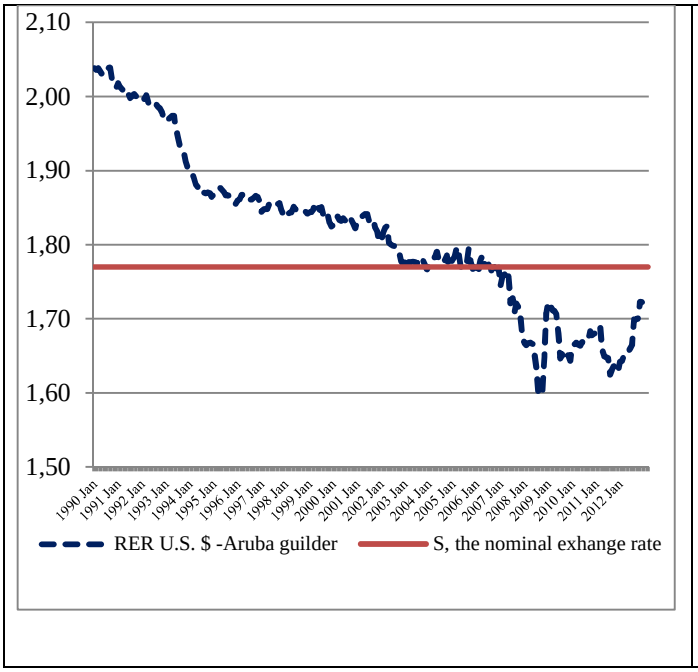
The advantage of the WPI is that it contains a higher share of tradable goods and services compared to the CPI. The advantage of the GDP deflator is that the price of export of services is included in it. Meanwhile, the WPI and the GDP deflator both have the disadvantage that these indices are not measured in (all of) the Caribbean micro-islands. Hence, to increase the sample size of Caribbean micro-economies based on availability of data, the CPI is preferred.

The CPI data of Caribbean micro-islands were selected on consistency of their monthly CPI time series. The CPIs of Aruba, the Bahamas, Barbados, and the three ECCU countries of Dominica, Saint Kitts and Nevis, and Saint Lucia were obtained from the IFS of the IMF. The CPI of Curaçao was obtained from the CBS.[48] As the currencies of the selected islands are pegged to the US dollar, the CPI of the United States was selected as the foreign price. The exchange rate pegs and the CPI of the United States were obtained from the IFS of the IMF. All

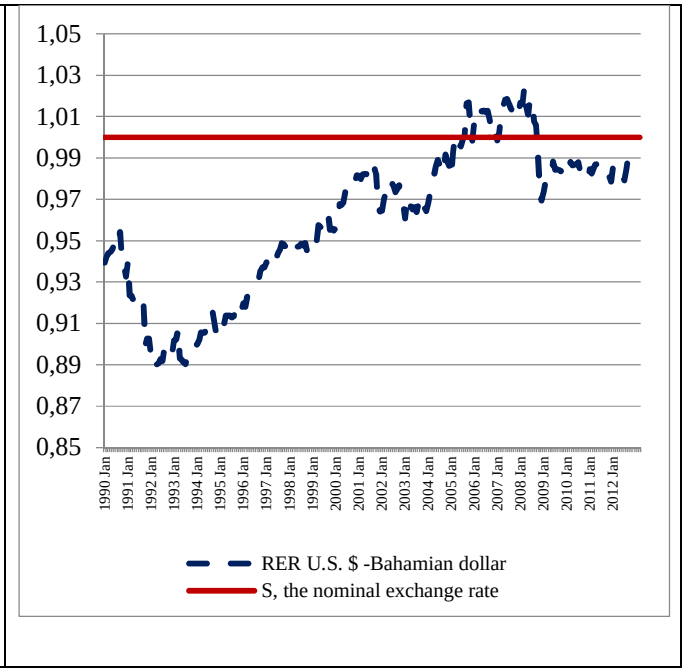
[48] In the IFS, the CPI data for Curaçao before 2006 consisted of combined CPIs of the two islands of Bonaire and Curaçao. In contrast, the CPI data of the CBS Curaçao consisted of data for the island of Curaçao. Thus, the data from the CBS Curaçao are preferred. The data are available on the CBS website, http://www.cbs.cw.

IFS data were retrieved on August 28, 2013. The sample period consisted of monthly data from January 1990−December 2012.

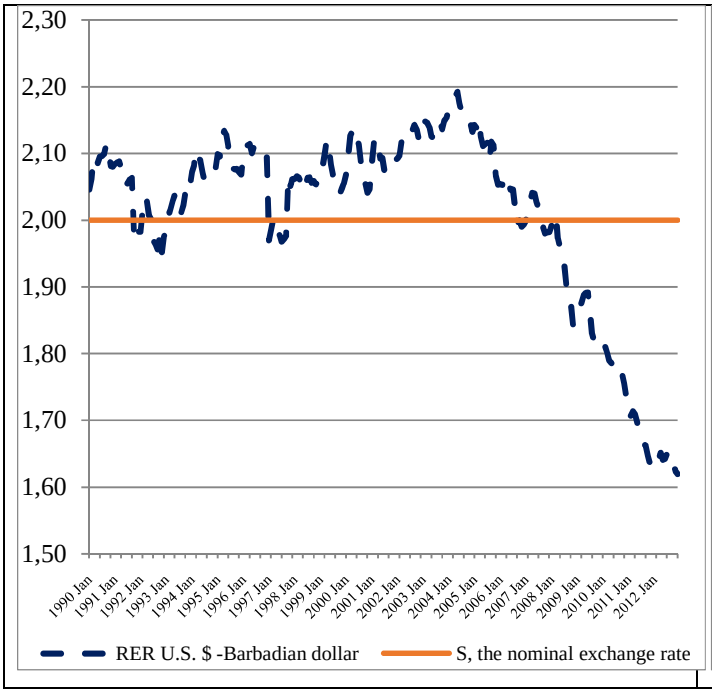
Figure 6.1 displays the RERs of the selected micro-economies (the dashed line) and the nominal exchange rate, $S_t$ (as defined in Equation (6.1)), which in this case is a peg ($S_t = S$) and therefore a horizontal line on the graph. The vertical axis lists the domestic currency. The trough in the RERs in 2008 reflect the global financial crisis. In particular, the islands of Barbados (Figure 6.1*c*), Curaçao (Figure 6.1*d*.), and Saint Lucia (Figure 6.1*g*) show high volatility in the RER after 2008. The graphs of the Caribbean micro-islands illustrate that the RER is not constant; hence, the absolute PPP does not hold for the Caribbean micro-islands. The graphs also show that with the exception of Saint Lucia (showing a mean reversion), the RERs exhibit a constant and a trend.



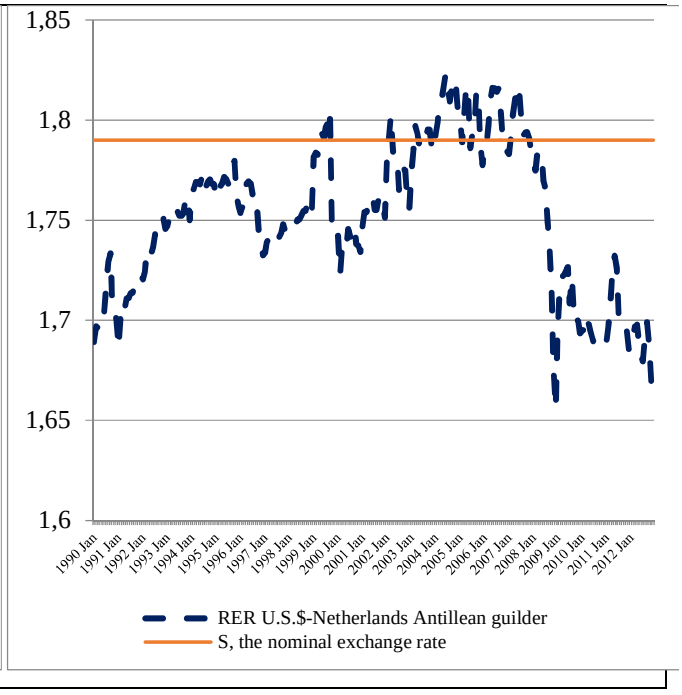

**a. Aruba**



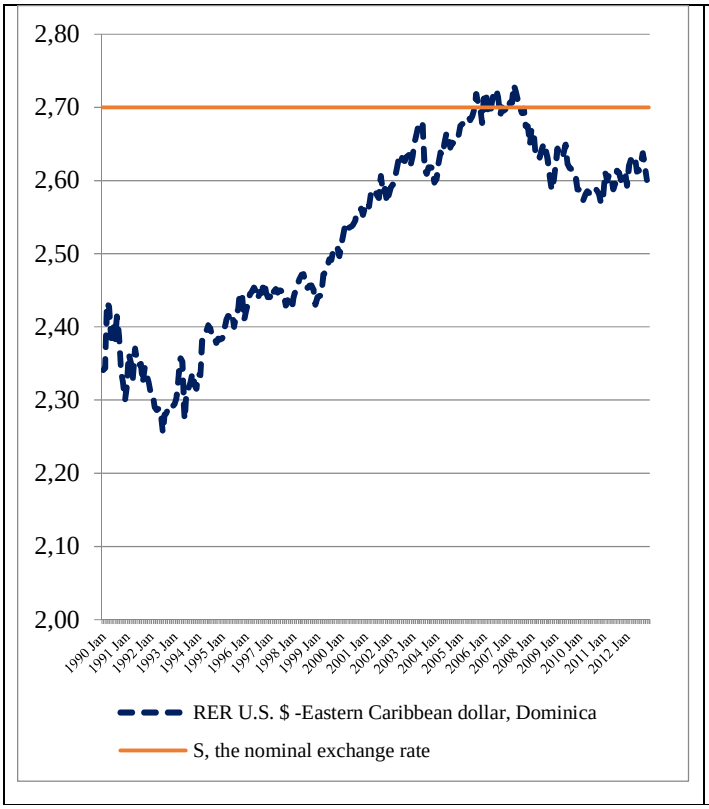

**b. The Bahamas**



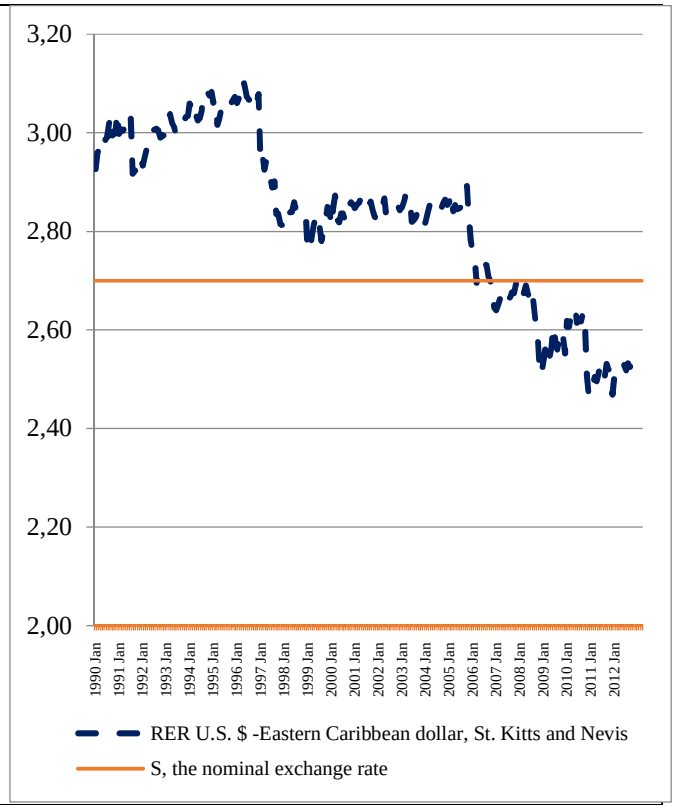

**c. Barbados** .



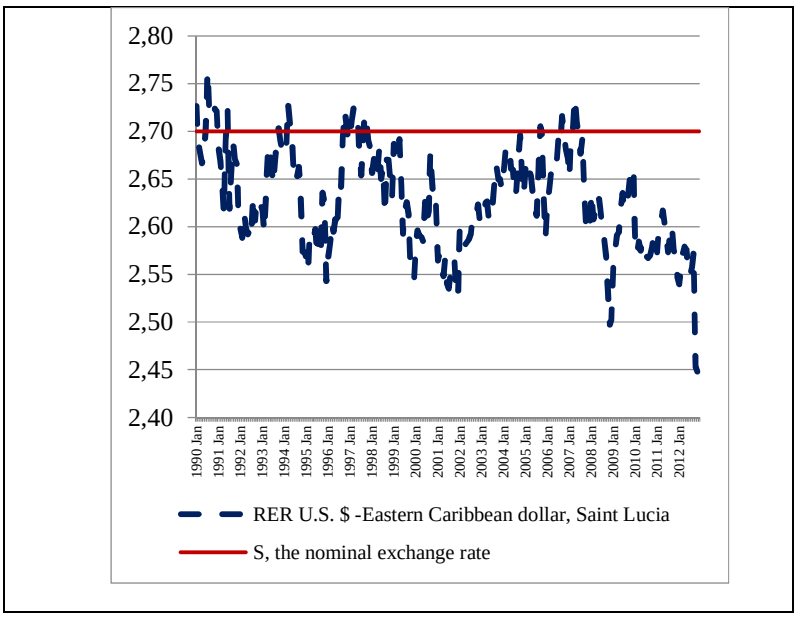

**d. Curaçao**




**e. Dominica**




**f. Saint Kitts and Nevis**




**g. Saint Lucia**

*Figure 6.1.* The RERs between the US and selected Caribbean micro-islands (in the domestic currency, in January 1990–December 2012). Source: IFS and CBS Curaçao.

Table 6.1 presents the statistics of the inflation rates by country and the RER with the United States. The means and standard deviations of the RER by country are shown in Columns 2 and 4, respectively. The RER is calculated using the left-hand side of Equation (6.3). The peg (the third column) is the nominal exchange rate with the US dollar, specifically the amount of domestic currency for 1 US$. The average month-to-month inflation rate in the period of January 1990−December 2012 is shown in Column 5. The statistics in Column 4 show high volatility in the RER, which is inconsistent with the third assumption of a constant RER, thereby violating the absolute PPP. Prices in Caribbean micro-islands are not equal to those in the United States, probably due to the high transportation costs, among other things.

Table 6.1

*Statistics of the RER and its Components for Selected Caribbean Micro-islands (January 1990–December 2012)*

| RER with the US | Mean RER[a] | the peg = S[b] | Standard deviation of the RER | Mean of the month–to-month inflation rate (%)[c] |
|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) |
| Aruba | 1.82 | 1.77 | 0.11 | 0.23 |
| Bahamas | 0.96 | 1.00 | 0.04 | 0.17 |
| Barbados | 2.00 | 2.00 | 0.14 | 0.29 |
| Curaçao | 1.75 | 1.79 | 0.04 | 0.20 |
| Dominica (ECCU[d]) | 2.53 | 2.70 | 0.13 | 0.17 |
| Saint Kitts & Nevis (ECCU[d]) | 2.83 | 2.70 | 0.17 | 0.23 |
| Saint Lucia (ECCU[d]) | 2.63 | 2.70 | 0.05 | 0.23 |

*Note.*

[a.] The RER is defined in the left-hand side of Equation (6.3).

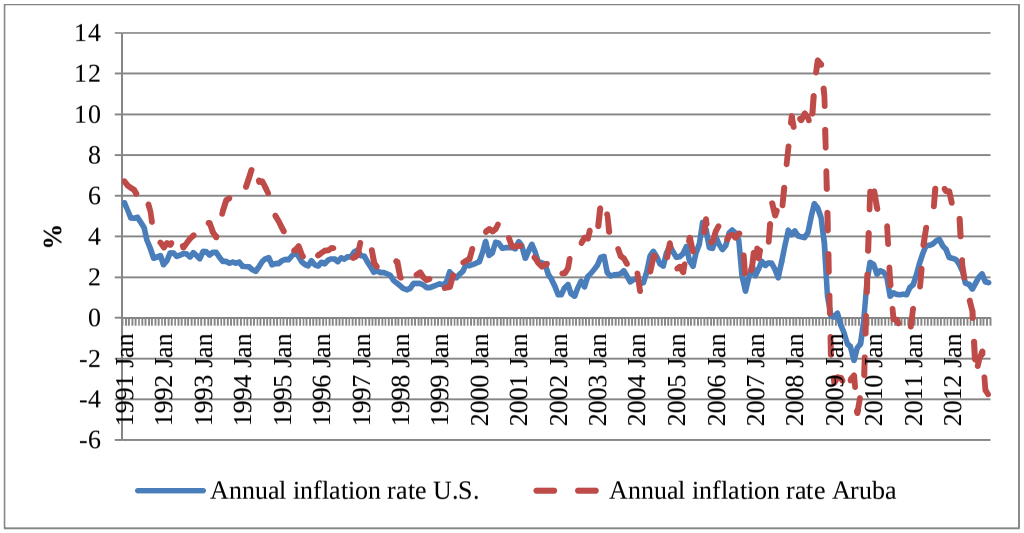
[b.] The peg is the exchange rate in domestic currency for 1 US$.

[c.] Only the mean is shown, as the difference between the mean and the median is negligible.

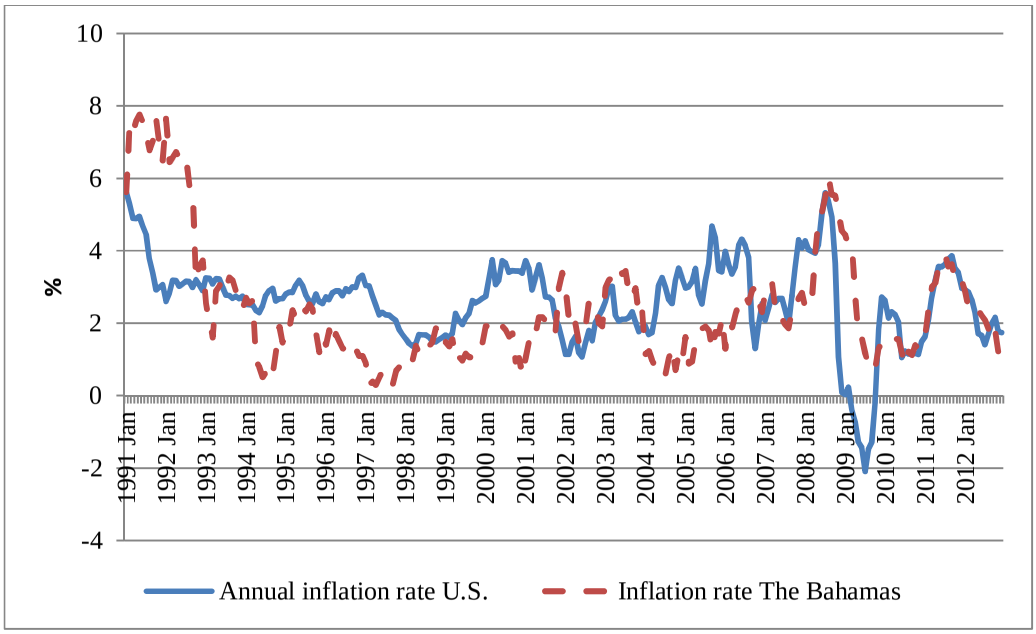
[d.] ECCU is the Eastern Caribbean Currency Union.

Source: IFS, CBS Curaçao.

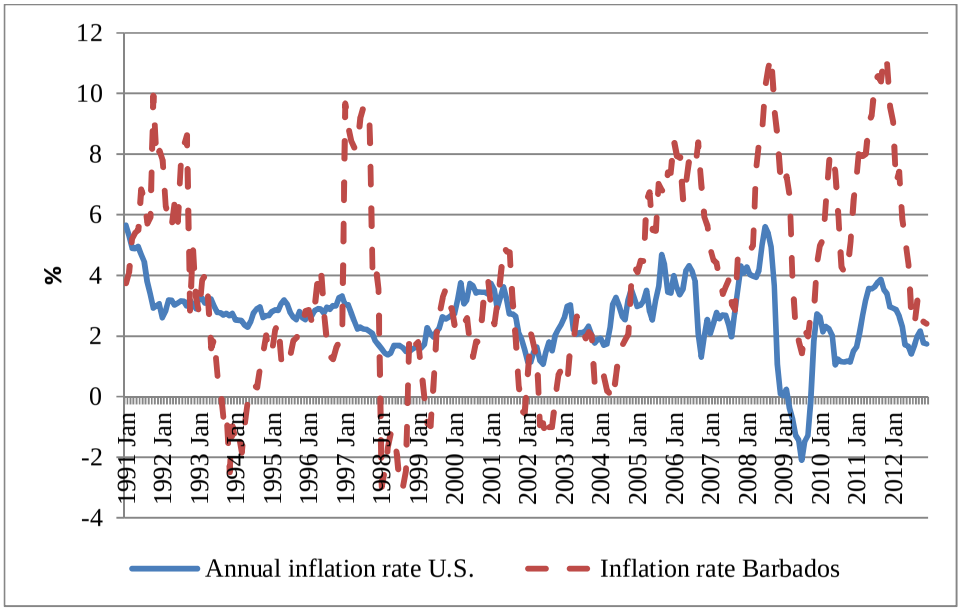
If the relative PPP in a fixed-exchange-rate system holds, then the inflation rates between the anchor country and the micro-economy are equal (Equation (6.6*a*)). The tests on the relative PPP, however, have a broader definition, and the PPP in a fixed-exchange rate system holds when the deviations from the PPP have a (non)linear specification. A preliminary assessment of the equality of the inflation rates was explored using two methods of estimating inflation. The first method was the month-to-month inflation rates of the micro-islands and the United States, and the second was the annual inflation rates of the micro-islands and the US. For the first method, the US month-to-month inflation rate of 0.18% is compared with the month-to-month inflation by country in Table 6.1. The statistics in this table show that with the exception of Barbados, the month-to-month inflation rates approximated month-to-month inflation of the US. The second method is shown in the graphs in Figure 6.2, where the annual inflation is defined as the CPI percentage change of month *t* and month *t-12*. The graphs in Figure 6.2 (*a* to *f*) show the inflation rates of the selected micro-islands and the United States.



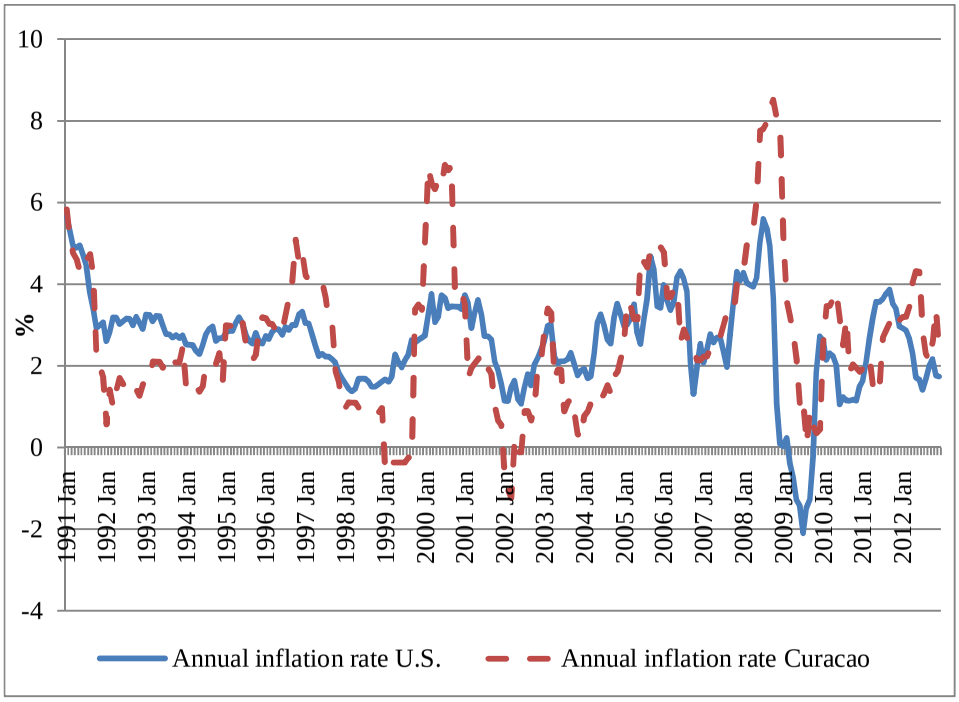

**a. Aruba**



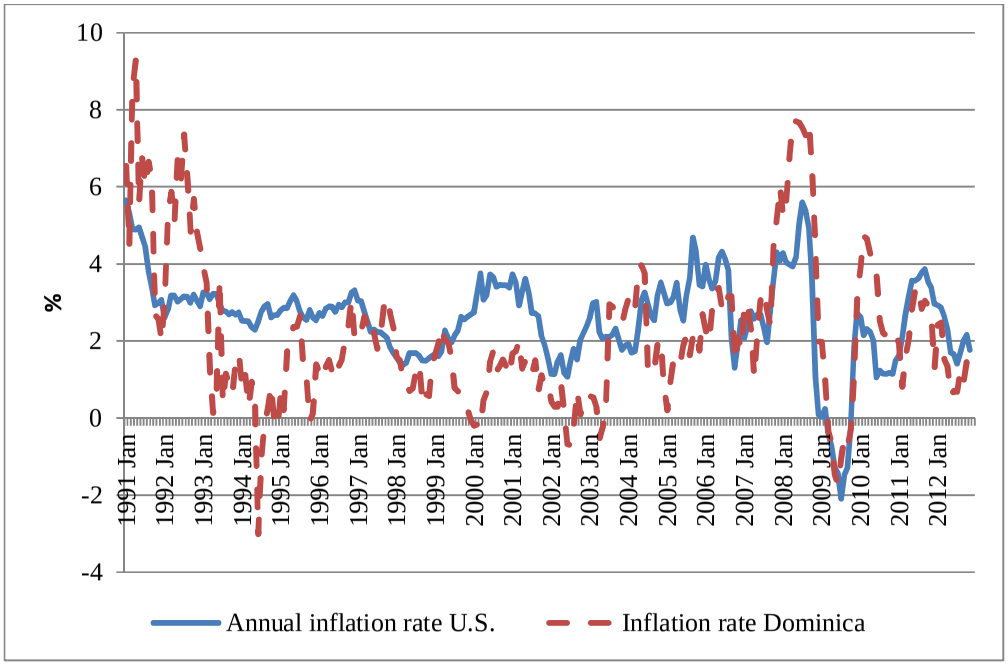

**b. The Bahamas**



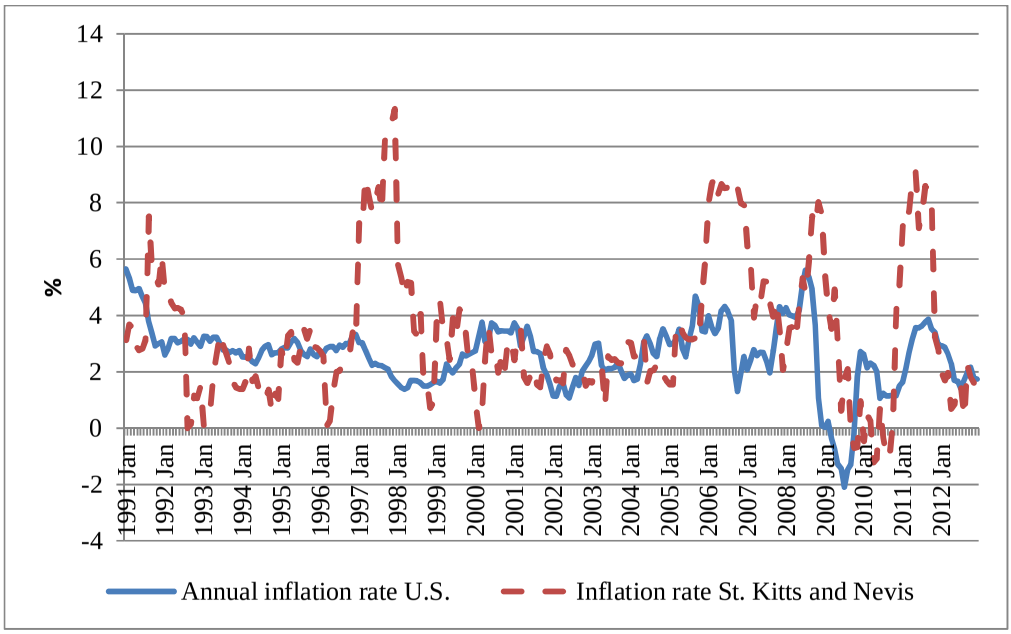

**c. Barbados**



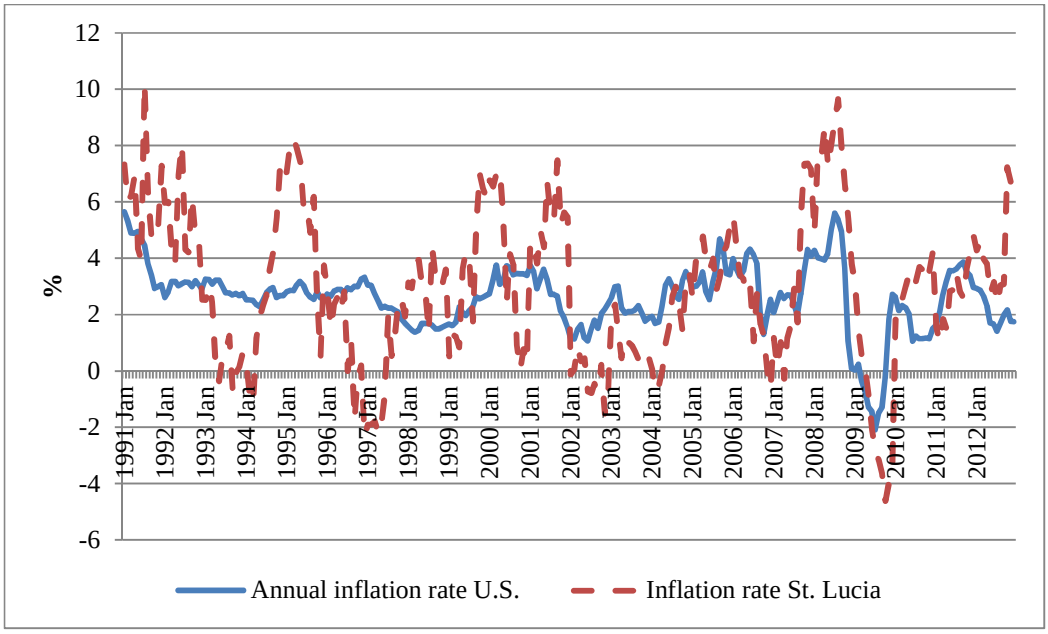

**d. Curaçao**




**e. Dominica**




**f. Saint Kitts and Nevis**




**g. Saint Lucia**

*Figure 6.2*. Inflation rates of the US and a Caribbean micro-island (in percent, January 1991–December 2012). Source: IFS and CFS Curaçao.

The graphs show that there are inflation rates differentials between the US and the Caribbean islands. Another important observation is the fact that the graphs show a co-movement between the US inflation rates and those of Aruba (6.2.*a*.), Curaçao (6.2.*d*.), Saint Kitts and Nevis (6.2.*f*.), and Saint Lucia (6.2.*g*.). The co-movement in the inflation rates may indicate that the deviations from the PPP ($\Delta\pi \neq 0$) have a (non)linear specification (see Equation (6.6a)), and hence that the PPP may apply.

To summarize, the data and the graphical presentation showed that the absolute PPP does not hold in the case of the Caribbean islands of Aruba, the Bahamas, Barbados, Curaçao, Dominica, Saint Kitts and Nevis, or Saint Lucia. The statistics and graphical illustrations of the data of the selected Caribbean micro-islands indicate that the relative PPP, may hold in Aruba, Curaçao, Saint Kitts and Nevis, and Saint Lucia and is less likely to hold in Barbados.

## 6.4. Empirical Results

The relative PPP tests on the Caribbean micro-islands of Aruba, the Bahamas, Barbados, Curaçao, Dominica, Saint Kitts and Nevis, and Saint Lucia are presented in this section. When the PPP holds, the deviations of the PPP are presented through linear or nonlinear specifications.

### 6.4.1. The Results of the Linear Specification

Table 6.2 provides *t*-statistics for the linear and the nonlinear specifications. In the second column of Table 6.2, the ADF *t*-statistic ($t_{ADF1}$) of the unit root of the RER is presented. A rejection of the unit root means that the relative PPP holds. Table 6.2 shows that the test on non-stationarity of the RER was not rejected in the linear specification for Aruba, Barbados, the Bahamas, Curaçao, and Dominica. The ADF test rejected the null hypothesis of a unit root in the RER for Saint Kitts and Nevis at a 10% significance level and for Saint Lucia at a 1% significance level. Hence, using a linear specification and applying the null of non-stationarity of the RER, the relative PPP holds for Saint Lucia and weak evidence that the PPP holds was found for Saint Kitts and Nevis. An alternative test on the linear specification of the deviations of the PPP is the test of the null hypothesis of no co-integration (Equation (6.8)). The *t*-statistic, $t_{ADF2,}$ is displayed in the third column of Table 6.2. Consistent with the graphs in Figure 6.2, which show the RERs with a constant and a trend for all islands except Saint Lucia, the ADF test with a constant and a trend have been applied to all RERs except that of Saint Lucia. For Saint Lucia, the ADF with a constant was applied. The results show that only for Saint Lucia are prices are co-integrated with US prices.

Table 6.2

*Unit Root Tests of the Linear and Nonlinear Specifications (January 1990–December 2012)*

| Country: | $t_{ADF1}$ [a] | $t_{ADF2}$ [b] | $t_{NL}$ [c] |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| Saint Lucia | –3.86***[d] | –4.29**[d] | –2.15[e] |
| Saint Kitts & Nevis | –3.22* | –3.26 | –3.76** |
| Curaçao | –2.31 | –2.33 | –3.70** |
| Aruba | –2.79 | –3.23 | –3.60** |
| Bahamas | –2.03 | –2.17 | –3.25* |
| Barbados | –0.52 | –0.33 | –0.36 |
| Dominica | –1.69 | –1.87 | –2.40 |

*Notes*.

[a] The 10%, 5%, and 1% asymptotic critical values for the $t_{ADF1}$ with constant and a trend are –3.13, 3.43, and –3.99.

[b] The 10%, 5%, and 1% asymptotic critical values for the $t_{ADF2}$, hypothesis $\rho = 0$ with two variables in the co-integrating relation with a constant and a trend are 3.84, –4.16, and –4.64 (Phillips & Ouliaris, 1988). A constant and trend is applied to all islands excluding Saint Lucia.

[c] The 10%, 5%, and 1% asymptotic critical values for the $t_{NL}$ for the de-trended RER are –3.13, –3.40, and –3.93 (Kapetanios et al., 2003, p. 364).

[d] The RER with a constant is applicable to Saint Lucia.

[e] The 10%, 5%, and 1% asymptotic critical values for the $t_{NL}$ for the de-meaned RER are –2.66, –2.93, and –3.48 (Kapetanios et al., 2003, p. 364).

*, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively

To summarize, the RER is stationary for Saint Lucia and Saint Kitts and Nevis. For the island of Saint Lucia, the deviations from the PPP can be specified by a co-integration relation between its domestic prices and US prices. Hence, the relative PPP holds for these two islands.

### 6.4.2. The Results of the Nonlinear Exponential Smooth Transition Autoregressive Models

The nonlinear specification of the ESTAR model, as proposed in Equation (6.10), was estimated for the selected micro-islands. The fourth column of Table 6.2 shows the *t*-statistic ($t_{NL}$) of the nonlinear specification of the deviations of the RER. The RER of Saint Lucia shows only a constant; therefore, this RER is de-meaned (Figure 6.1). The unit root of the de-meaned RER was not rejected for Saint Lucia; hence, the nonlinear ESTAR model was not applied for this island. The RERs except that of Saint Lucia show a constant and a trend (Figure 6.1). Hence, the $t_{NL}$ test is applied on the de-trended RERs for all countries except Saint Lucia. The null hypothesis of a unit root of the de-trended RER was rejected for Aruba, the Bahamas, Curaçao, and Saint Kitts and Nevis. Hence, I proceed with the estimation of the nonlinear ESTAR models for these four islands.

The speed of adjustment of the RERs in four Caribbean islands, the $\widehat{\theta}$ in Equation (6.9), is estimated with the maximum likelihood estimator and is approximately 0.46 for these four countries (Table 6.3). The *t*-values show that the speed is highly significant at a 1% significance level. The speed can be considered as moderate, as it is not extremely small (too close to zero) in comparison to the speeds of Australia, France, Germany, Italy, New Zealand, and the United Kingdom in Kapetanios et al. (2003), which varied from 0.002 to 0.032.

Table 6.3

*The ESTAR Model for Selected Caribbean Micro-islands (MLE, January 1990–December 2012)*

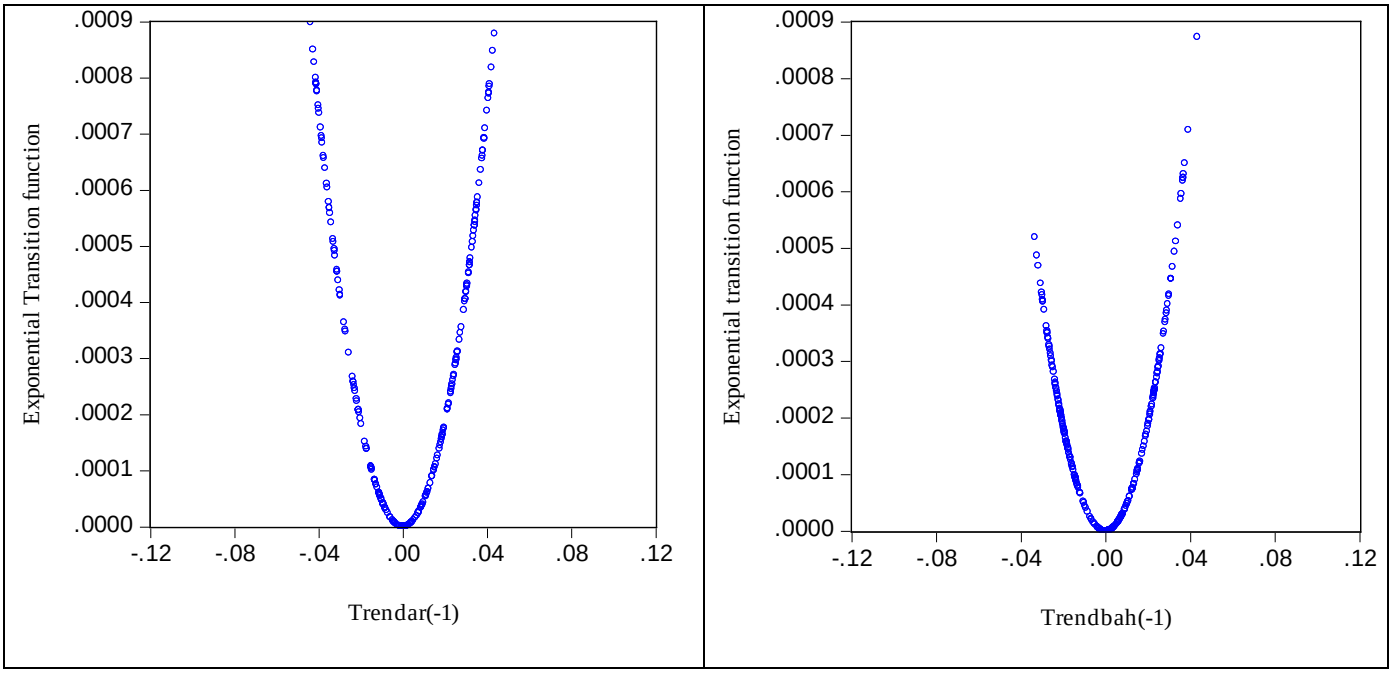
| Country | $\hat{\theta}$ | s.e. $(\hat{\theta})$[a] | *t*-value |
|---|---|---|---|
| Aruba | 0.465*** | 0.152 | 3.06 |
| Bahamas | 0.465*** | 0.152 | 3.06 |
| Curaçao | 0.460*** | 0.153 | 3.01 |
| Saint Kitts & Nevis | 0.453*** | 0.154 | 2.94 |

*Notes*.

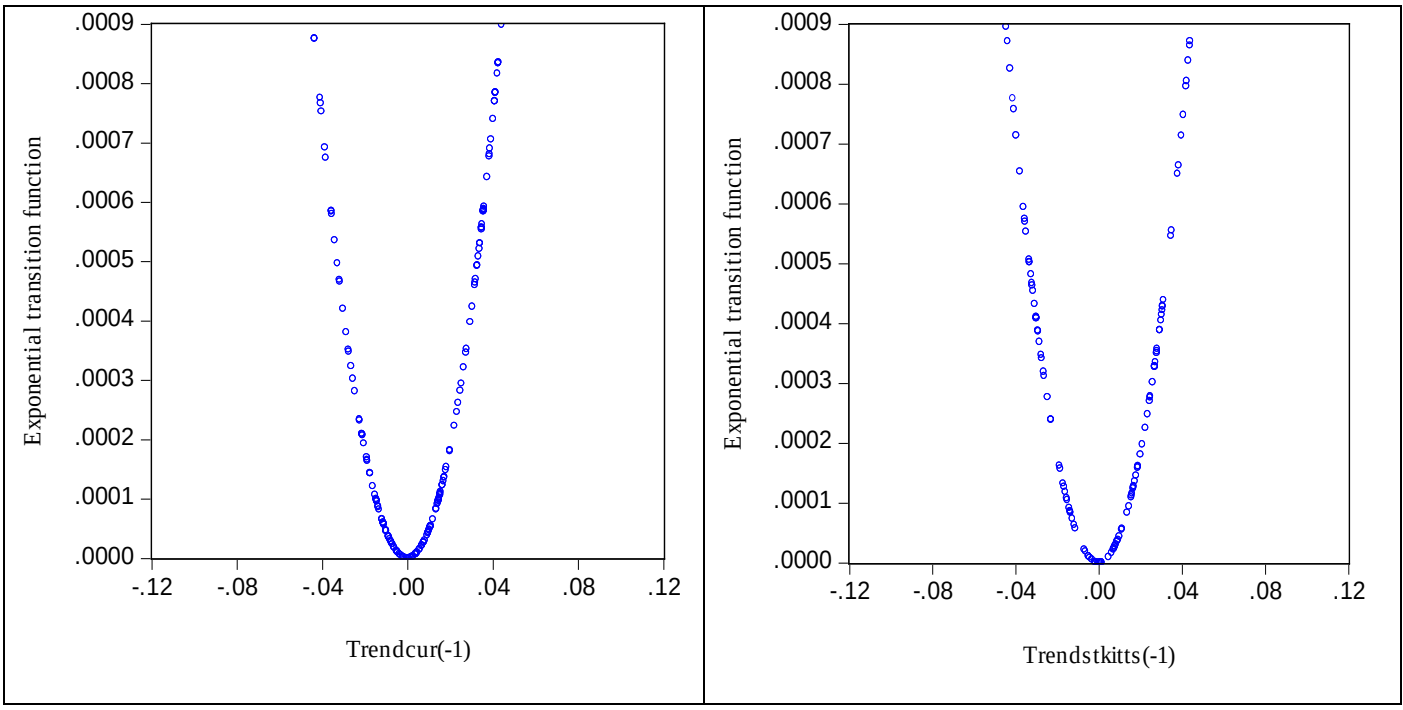
[a].s.e. = standard error. $\hat{\theta}$ is the maximum likelihood estimator (MLE) estimated with imposing $\gamma$ = -1,The RERs are de-trended

*** means significant at 1%

Figure 6.3 shows the exponential transition functions $[1 - \exp(-\theta y_{t-1}^2)]$. The deviations from the RER (on the horizontal axis) are symmetrically allocated on the exponential transition functions and differ by country. In Aruba, the deviations from the RER (defined in Figure 6.3.*a* by the variable trendar(-1)) lie in the [-0.06, 0.06] range. The variable trendbah(-1) for the Bahamas, the variable trendcur(-1) for Curaçao, and the variable trendstkitts(-1) for Saint Kitts and Nevis show that the deviations from the RER lie in the smaller range of [-0.04, 0.04]. The deviations from the RER in the micro-islands are small, with an absolute maximum range of 0.06. The transition functions (shown on the vertical axis) lie below 0.0009 for all selected countries, which implies slow transitions. The relative PPP holds for the Caribbean micro-islands of Aruba, Barbados, Curaçao, and Saint Kitts and Nevis. For these islands, the smooth nonlinear specification (ESTAR) applies. The nonlinear specification and the weak evidence for a stationary RER of Saint Kitts and Nevis imply that this country is probably a borderline case between a linear and a nonlinear specification.




**a. Aruba** **b. The Bahamas**




**c. Curaçao** **d. Saint Kitts and Nevis**

*Figure 6.3.* The exponential transition functions in selected Caribbean micro-islands (January 1990–December 2012).

### 6.4.3. The Results of the Nonlinear Transition Autoregressive Models

The long-run equilibria were estimated using Equation (6.7). The residuals of this equation are considered as deviations from the PPP. The residuals of Equation (6.7) were tested for unit root ($H_o$: $\rho = 0$) in Equation (6.8). Only for Saint Lucia was the null hypothesis of no co-integration rejected (Table 6.2, third column, $t_{ADF2}$). The PPP held for Saint Lucia and was presented by a linear specification. The SC was used to determine the appropriate lag lengths, as $\varepsilon_t$ in Equation (6.8) was assumed to be white noise. The results for the lag lengths and $\rho$, the speed of adjustment, are presented in Table 6.4. The table shows $\rho$ for all selected islands, although only the long-run equilibrium for Saint Lucia was established. In the case of Saint Lucia, the speed of adjustment of the positive and negative deviations from the long-run PPP was 14.1%.

Table 6.4

*The Estimated Adjustment in the Standard Co-integration (January 1990–December 2012)*

| Country | ρ | Lags SC |
|---|---|---|
| Saint Lucia | –0.1405 | 0 |
| Aruba | –0.0731 | 1 |
| Saint Kitts & Nevis | –0.0621 | 0 |
| Curaçao | –0.0353 | 1 |
| Dominica | –0.0284 | 0 |
| Bahamas | –0.0275 | 0 |
| Barbados | –0.0030 | 0 |

*Note*.
Lags are determined according to the Schwartz criterion (SC).

For the remaining micro-islands, the following step was carried out to test whether the nonlinear asymmetric specifications of the TAR or MTAR would fit the data. The results for TAR and MTAR are presented in Tables 6.5 and 6.6, respectively. These models assume that there are two slopes (two regimes) in the adjustment processes. The second and third columns of

Table 6.5 show the two slopes $\rho_1$ and $\rho_2$ of the regressions. The first slope applies to the observations above a threshold (a positive deviation), while the second slope is for the observations below a threshold (a negative deviation). The fourth column presents the test statistic $\Phi$ for no co-integration with $H_o$: $\rho_1 = \rho_2 = 0$. The null hypothesis of no co-integration is rejected in the case of Saint Kitts and Nevis at a 5% significance level. As the critical values of the maximum of four lags are tabulated, the case of Saint Lucia, with six lags of the statistic $\Phi$, is not accounted for. However, the linear co-integration specified with one speed of adjustment, $\rho$=14.05% (Table 6.4 in Section 6.5.2), implies a rejection of the null hypothesis of no co-integration. In the fifth column, the test of the symmetric adjustment with similar slopes ($\rho_1 = \rho_2$) is presented. Again, there four maximum lags of the critical values; hence, the critical values for the statistic of Saint Lucia, with six lags, were not tabulated. The hypothesis of a symmetrical speed of adjustment should likely not be rejected for Saint Lucia. This is consistent with the *linear* specification found in Section 6.5.2 ($t_{ADF2}$ test in Table 6.2), with one speed of adjustment. The speed of adjustment, the $\rho$ of Saint Lucia equals 14.05% (Table 6.4). For Saint Kitts and Nevis, the hypothesis of two similar slopes is rejected. The other Caribbean micro-economies showed no co-integration.

The sixth column in Table 6.5 shows the threshold values. On the Caribbean micro-island of Saint Kitts and Nevis, the positive deviation (above the threshold of $\tau$ = -0.0184) adjusts at a lower absolute speed of 2.08% than those below the $\tau$ (a negative deviation), with a speed of adjustment of 13.4% (Table 6.5). Saint Kitts and Nevis has a negative threshold. As the original data are transformed in logs, the negative values mean that the actual values are in the range of [0,1]. Hence, the actual threshold values are less than unity. Negative threshold values were also reported in a few African countries (Chang et al., 2011), some European

countries (Enders & Dibooglu, 2001), and a few Pacific countries (Enders & Chumrusphonlert, 2004). A possible interpretation of the threshold value is offered in the study of Enders and Chumrusphonlert (2004), where the value is interpreted as the long-term equilibrium of the PPP.

Table 6.5

*The TAR Models for Selected Caribbean Micro-islands (January 1990–December 2012)*

| Country (1) | $\rho_1$ (2) | $\rho_2$ (3) | $\Phi$ [a] (4) | $\rho_1=\rho_2$ [b] (5) | $\tau$ [c] (6) | Lags (7) |
|---|---|---|---|---|---|---|
| Saint Kitts & Nevis | –0.0208 | –0.1342 | 8.369** | 7.6763*** | –0.0184 | 4 |
| Saint Lucia | –0.1151 | –0.1522 | 5.847 | 0.3175 | –0.0158 | 6[d] |
| Barbados | –0.01367 | –0.0017 | 0.7179 | 0.4467 | –0.0449 | 2 |
| Bahamas | –0.0705 | –0.0055 | 5.3859 | 6.0193*** | 0.0279 | 1 |
| Aruba | –0.0521 | –0.1086 | 5.7607 | 1.5298 | –0.0126 | 2 |
| Curaçao | –0.0579 | –0.0143 | 2.7741 | 1.8826 | 0.0248 | 4 |
| Dominica | –0.0109 | –0.0582 | 2.5964 | 2.1727 | –0.0351 | 1 |

*Notes.*

[a] The test statistic for $\Phi$ for no co-integration: $H_o$: $\rho_1= \rho_2=0$. Entries in this column are the non-standard *F* statistics. The critical values of the non-standard *F*–statistics are reported in Enders and Siklos (2001) and depend on the numbers of lags and the number of observations.

[b] The null hypothesis is $H_o$: $\rho_1= \rho_2$. Entries in this column are standard *F* statistics for the null hypothesis of a symmetric adjustment.

[c] The threshold value $\tau$ in $I_t = \begin{cases} 1, & u_{t-1} \geq \tau \\ 0, & u_{t-1} < \tau \end{cases}$.

[d] The maximum lags reported in Enders and Siklos (2001) were 4.

*, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table 6.6

*The M-TAR Models for Selected Caribbean Micro-islands (January 1990–December 2012)*

| Country | $\rho_1$ | $\rho_2$ | $\Phi$ [a] | $\rho_1=\rho_2$ [b] | $\tau$[c] | Lags |
|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Aruba | –0.1889 | –0.0527 | 7.7327* | 5.3329*** | 0.0032 | 2 |
| Saint Kitts & Nevis | –0.0419 | –0.1549 | 6.6927* | 4.445** | –0.0005 | 4 |
| Saint Lucia | –0.0901 | –0.1862 | 6.8089 | 2.1608 | –0.0019 | 6[d] |
| Barbados | 0.0029 | –0.0163 | 1.0626 | 1.1337 | 0.0012 | 2 |
| Bahamas | –0.0769 | –0.0181 | 3.8106 | 2.922 | 0.0043 | 1 |
| Curaçao | –0.0159 | –0.0592 | 2.711 | 1.7589 | –0.0013 | 4 |
| Dominica | –0.0429 | 0.0029 | 2.5686 | 2.1176 | –0.0014 | 1 |

*Notes*.

[(a)]Entries in this column are the non-standard *F*-statistics for null hypothesis of $\rho_1= \rho_2=0$. The critical values of the non-standard *F*-statistics are reported in Table 1 of Enders and Siklos (2001) depend on the numbers of lags and the number of observations.

[(b)]Entries in this column are standard *F*-statistics for null hypothesis of a symmetric adjustment.

[(c)] The threshold value $\tau$ in $M_t = \begin{cases} 1, & \Delta u_{t-1} \geq \tau \\ 0, & \Delta u_{t-1} < \tau \end{cases}$

[(d)]*,**, and *** indicate significance at 10%, 5%, and 1% levels, respectively

MTAR is an alternative to a nonlinear adjustment of the RER. In this case, the change of the deviations from the RER are analyzed. The second and third columns of Table 6.6 present the two speeds of adjustment. The MTAR models in Table 6.6 show that the $\Phi$ statistic of no co-integration is rejected for Aruba and Saint Kitts and Nevis. As the critical values are tabulated to a maximum of four lags, the critical values for the statistic $\Phi$ of 6.8089 with six lags for Saint Lucia are unavailable. MTAR and TAR for Saint Kitts and Nevis show asymmetric adjustment. Aruba's MTAR also has an asymmetric speed of adjustment. For deviations above the threshold ($\tau > 0.0032$), the speed of adjustment is high at 18.89%, and deviation below the threshold (for $\tau < 0.0032$) of the speed of adjustment is 5.27%.

A linear specification of the deviation from the RER is not rejected for the countries of Saint Kitts and Nevis and Saint Lucia. The departure from the RER of Saint Lucia had a linear specification with one absolute speed of adjustment of 14.05%. In Saint Kitts and Nevis, weak evidence was found for a linear specification, as the unit root of the RER was rejected at the 10% significance level. However, no co-integration between the prices of the United States and those of Saint Kitts was found. Hence, Saint Kitts and Nevis is considered as a possibly borderline case between linear and nonlinear specification. Following the weak evidence for a linear specification in Saint Kitts and Nevis, the deviation from the PPP showed an asymmetric adjustment to the long-term PPP (TAR at 5% significance) and a symmetric adjustment of ESTAR (at 1% significance).

More specifically, the deviations of Saint Kitts and Nevis were modeled by a TAR with a threshold of -0.0184 and the speed of 2.08% above the threshold and a speed of adjustment of 13.42% below the threshold, as well as by an MTAR result with speeds of 4.19% for positive deviation and 15.49% for negative deviation or ESTAR with a speed of adjustment of 0.45. Having both nonlinear specifications is plausible, as ESTAR is a generalization of TAR (Appendix 6).

The country of Aruba had two nonlinear specifications for the departure from the RER, an asymmetric specification of the MTAR with two speeds of adjustment of 18.85% and 5.27%, or a symmetric adjustment of the ESTAR with a speed of adjustment of 0.46. The departure from the PPP of the Bahamas had an ESTAR specification with a speed of adjustment of approximately 0.46. Curaçao, the micro-island with short-run sticky prices, showed a nonlinear ESTAR adjustment; thus, the PPP holds. Hence, although prices were sticky, these deviations did not have an impact on the deviations of the PPP in the long run.

Table 6.7 summarizes the results of the PPP hypothesis for selected Caribbean micro-islands pegged to the US dollar. The absolute PPP was rejected, as none of the islands had a constant RER (Figure 6.1). The nonlinear specification provided a useful alternative to the linear tests of the relative PPP for the Caribbean micro-islands. The relative PPP has five tests that are shown in Table 6.7, partitioned into linear (Columns 3 and 4) and nonlinear specifications (Columns 5, 6, and 7). The relative PPP was rejected for two out of seven Caribbean micro-islands. The possible explanation for the rejection of the PPP in Dominica and Barbados lies in the shocks affecting the RER in both countries.

In contrast to the two other selected members of the ECCU—Saint Kitts and Nevis and Saint Lucia—the island of Dominica did not support the PPP hypothesis with the United States as the anchor country in the period of 1990–2012. One of the factors that may have influenced the RER with the US dollar is the depreciation of the pound sterling in 1992. This led to a change in the sterling/dollar exchange rate and hence the sterling/ECCU $. Dominica,[49] with its higher share of agricultural exports to the United Kingdom compared to the other two ECCU countries, was severely affected. In addition, the higher prices of imports from the UK led to high imported inflation in Dominica and overall inflation in Dominica, and increased the volatility in the RER. As a former British colony, Barbados was also affected by the depreciation of the pound against the US dollar in 1992. This economy was severely affected due to the large share of tourists from the United Kingdom. The depreciation resulted in high imported inflation, which increased the overall inflation and the volatility of the RER. Another

[49] Dominica, a former British colony, is a volcanic island with hardly any beaches. Tourism is comparatively less developed than on the other Caribbean islands. Its largest share of tourists originates from the Caribbean area. Dominica has relatively higher agricultural production compared to the other Caribbean micro-islands. Banana was the main export to the United Kingdom until till the European Union decided to phase out the preferred access of bananas in 2006.

source of the departure from the PPP may be related to the balance of payment disequilibria in the 1990s.

High transportation costs as part of the transaction costs are often mentioned as one of the reasons for rejecting the PPP. Caribbean micro-islands have high transportation costs, which could result in such rejection. The results showed that for five out of seven Caribbean micro-islands the PPP was not rejected. The results also showed that despite the motivation for a nonlinear approach due to transportation costs, Saint Lucia—a micro-island with high transportation costs—fit a linear specification. Another factor reported as a cause of deviation from the PPP is sticky prices. The results showed that despite the sticky prices in Curaçao, the PPP holds.

Table 6.7

*The PPP Hypothesis between the Caribbean Micro-islands and the United States*

| Exchange rates[a] | Absolute PPP<br>RER is constant | Relative PPP<br>linear test: $t_{ADF1}$<br>$H_o$: RER has a unit root | Relative PPP<br>linear test: $t_{ADF2}$<br>$H_o$: no co-integration | Relative PPP<br>Nonlinear model ESTAR, $t_{NL}$<br>$H_o$: unit root of $\theta$ | Relative PPP<br>Nonlinear model TAR<br>$H_o$: of no co-integration | Relative PPP<br>Nonlinear model M-TAR<br>$H_o$: of no co-integration |
|---|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Aruba: 1.77 AWG | PPP rejected | PPP rejected | PPP rejected | **PPP holds** | PPP rejected | **PPP holds** |
| Bahamas: 1.00 BSD | PPP rejected | PPP rejected | PPP rejected | **PPP holds** | PPP rejected | PPP rejected |
| Barbados: 2.00 BBD | PPP rejected | PPP rejected | PPP rejected | PPP rejected | PPP rejected | PPP rejected |
| Curaçao: 1.79 ANG | PPP rejected | PPP rejected | PPP rejected | **PPP holds** | PPP rejected | PPP rejected |
| Dominica: 2.70 XCD | PPP rejected | PPP rejected | PPP rejected | PPP rejected | PPP rejected | PPP rejected |
| Saint Kitts & Nevis: 2.70 XCD | PPP rejected | **PPP holds** | PPP rejected | **PPP holds** | **PPP holds** | **PPP holds** |
| St. Lucia: 2.70 XCD | PPP rejected | **PPP holds** | **PPP holds** | PPP rejected | **PPP holds** | **PPP holds** |

*Notes.*

[a] The exchange rates for 1 US $: the AWG is the Aruban guilder, BSD is the Bahamian dollar, BBD is the Barbadian dollar, ANG is the Netherlands Antillean guilder, XCD is the Eastern Caribbean dollar. The islands of Dominica, Saint Kitts & Nevis, and Saint Lucia are part of the Eastern Caribbean Currency Union (ECCU).

Source: Author's compilation.

## 6.5. Conclusions

The aim of this chapter was to test whether the absolute and relative PPP hold for selected Caribbean micro-islands. The PPP hypothesis is important in the economic literature, as the exchange rate alignments are based on this hypothesis. In the case of the Caribbean micro-islands, their high transportation costs may cause the PPP to fail. In addition, sticky prices in Curaçao may be a source for deviation from the PPP. Due to the lack of certainty on these issues, the PPP hypothesis was tested for this group.

In all of the selected Caribbean micro-islands—Aruba, the Bahamas, Barbados, Curaçao, Dominica, Saint Kitts and Nevis, and Saint Lucia—the absolute PPP hypothesis was rejected. The relative PPP hypothesis was tested for the same sample using linear and nonlinear specifications for the deviations from the PPP. The nonlinear specification was applied in cases of arbitrage costs. Hence, the nonlinear specification was preferred, as the Caribbean micro-islands have high transportation costs. Despite these high costs, the relative PPP hypothesis holds for the majority (five) of the selected (seven) Caribbean micro-islands. These results include Curaçao, the economy with sticky prices. In addition, in contrast to the commonly applied nonlinear specification in the literature, a linear specification applies to Saint Lucia, an island with high transportation costs. Ultimately, the relative PPP did not hold for Barbados or Dominica.

The rejection of the PPP for these islands was associated with the depreciation of the pound sterling in 1992, which represented an external shock to their RERs. These islands were greatly affected by this shock due to their large share of their exports to the United Kingdom—the export of bananas from Dominica and tourism to Barbados. As the relative PPP held for the majority of the micro-islands, neither high transportation costs nor sticky prices were factors that

led to the rejection of the PPP hypothesis in the selected Caribbean micro-islands. Accordingly, the nonlinear TAR and ESTAR models and linear co-integration were applied to these micro-islands.

The finding that the PPP holds for Curaçao is important, as it implies that sticky prices in Curaçao have no impact on its long-run prices. Hence, the PPP holds despite the sticky prices in Curaçao. Another important finding was that in contrast to what has commonly been reported in earlier literature, in the presence of arbitrage costs, the deviation from the PPP is not necessarily represented by a nonlinear approach; rather, a linear specification also applies. Hence, the nonlinear specification of the deviation from the PPP is not determined by the arbitrage costs.

References to Chapter 6

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Appendix 6: From a Symmetric to an Asymmetric Representation

This appendix shows the derivation of the asymmetric TAR representation from the symmetric adjustment of the ESTAR model presented in Sarno and Taylor (2002). A general STAR model is as follows:

$$[s_t - \mu] = \sum_{j=1}^{p} \beta_j [s_{t-j} - \mu] + \left(\sum_{j=1}^{p} \beta_j^* [s_{t-j} - \mu]\right)\Phi[\theta; s_{t-d} - \mu] + \varepsilon_t. \quad (6A.1)$$

Here, $\{s_t\}$ is a stationary ergodic process, and $\varepsilon_t \sim idd(0, \sigma^2)$. The transition function $\Phi[\theta; s_{t-d} - \mu]$ determines the smooth transition between the two regimes (one below and one above the equilibrium), and the parameter $\theta$ determines the speed of mean reversion. The parameter $\mu$ is the equilibrium value of $\{s_t\}$. The exponential function is a simple form of the transition function, as follows:

$$\Phi[\theta; s_{t-d} - \mu] = 1 - \exp(\theta^2 [s_t - \mu]^2). \quad (6A.2)$$

In Equation (6A.2), STAR becomes an exponential STAR (ESTAR). The transition function $\Phi : \Re \rightarrow [0,1]$ is symmetrically inverse and bell shaped around zero. This means that there is a smooth, symmetric transition of the RER between the positive and negative deviations from the equilibrium value. The lower $\theta$ means lower speed of adjustment. Sarno and Taylor (2002) use the terminology of *inner* and *outer regimes*. The inner regime is when $s_t = \mu$, and $\Phi = 0$. Equation (6A.1) is therefore a linear AR(p) model:

$$[s_t - \mu] = \sum_{j=1}^{p} \beta_j [s_{t-j} - \mu] + \varepsilon_t. \quad (6A.3)$$

In the outer regime, for a given $\theta$ equal to $\lim_{[s_{t-d} - \mu] \rightarrow \pm\infty} \Phi[\theta; s_{t-d} - \mu]$, Equation (6A.1) becomes a linear AR(p) model, but it is different from Equation (6A.3):

$$[s_t - \mu] = \sum_{j=1}^{p} (\beta_j + \beta_j^*)[s_{t-j} - \mu] + \varepsilon_t. \quad (6A.4)$$

For $\beta_j^* \neq 0$, there are two different speeds of mean reversion (Equations (6A.3) and (6A.4)), and this is an asymmetric TAR representation.

# CHAPTER 7

# CONCLUSIONS

Caribbean micro-islands have population sizes of less than half million inhabitants, resulting in commodity markets with a small size that is “economically disadvantageous” (Briguglio, 1995, p. 1616). The two main disadvantages facing the Caribbean micro-islands due to their smallness and their insularity are high transportation costs and a lack of comparative advantage among these islands.

In contrast to large economies, Caribbean micro-islands are price takers in the world market, and their domestic prices are presumed to fluctuate in line with world prices. Briguglio (1995) formulated this as follows: “SIDS have negligible control on the prices of products they import and export” (p. 1616). As a result, the domestic prices of SIDS are assumed to be flexible, as they are likely to adjust in line with world market price changes. However, prices are sticky on the Caribbean micro-island of Curaçao, implying that the commodity markets are in a state of disequilibrium, as they are not equal to the prices that would represent demand and supply. Consequently, this may result in misallocation of resources and the redistribution of income. Moreover, sticky prices on a micro-island challenge the hypothesis that small economies have flexible prices, and at the same time, it raises a question concerning the causes of price rigidity on a micro-island. This dissertation focused on explaining sticky prices on the micro-island of Curaçao.

The benchmark for sticky prices in this dissertation was when the price change frequency was lower than 22% of months. Curaçao, with its mean price change frequency of 9% of months, has sticky prices. The mean price change frequency of 9% of months is equivalent to the mean duration of price spells of 10 months. Therefore, prices in Curaçao are sticky in the

short run. Moreover, the stylized facts of the CPI micro-data showed price asymmetry, as price adjustments in commodity markets of Curaçao are sticky downward, meaning that prices are resistant to drop. Sticky downward prices are not consistent with the price stickiness caused by a kinked demand in an oligopolistic market, as in this theory, the competitive firms are reacting to price declines only. Hence, the kinked demand hypothesis is not applicable to Curaçao.

The determinants of price rigidity are presented in the price-rigidity theories. They are broadly categorized into state-dependent and the time-dependent pricing. In SDP hypotheses, the firms' decisions to change the price depend on the state of the economy, while in TDP hypotheses, the decisions to change the price occur independently of the state of the economy, and prices are changed periodically or at random. The price-rigidity theories were developed in large economies; hence, not all of these hypotheses are applicable to the micro-island of Curaçao. The state-dependent hypothesis that is likely to apply for Curaçao is attractive pricing, as 60% of the prices have a 5 or 9 digit-ending. According to the attractive pricing theory, firms set prices ending with 5 or 9 and hold these prices fixed until they can be changed to new attractive prices. However, the panel analysis of the micro-CPI data *excluding* energy prices, rental fees, insurance, and tariffs on postal services in the period of 2006–2010 rejected the hypothesis of attractive prices as a cause of sticky prices in Curaçao. Price regulation, a time-dependent hypothesis, states that regulated prices lead to sticky prices. Using the same panel analysis, the hypothesis of price regulation was also rejected.

The TDP hypotheses of seasonality and political interference, in contrast, supported sticky prices in Curaçao. The seasonality in the post-holiday season of the months of January in the category of clothing and footwear and February for all categories, as well as the political business cycle (Schuknecht, 1996) and regulatory capture (Peltzman, 1976) led to sticky prices.

The price stickiness in the months of January and February was probably related to the slow months after the Christmas season. The TDP hypothesis of political business cycle states that in the pre-election periods, policymakers are shy away from making any decision that may jeopardize their re-election. Policymakers postponed increasing energy prices following international price increases, but the occasional international energy price declines led to an immediate adjustment of domestic energy prices. A case of regulatory capture was the introduction of the Energy Fund in Curaçao, the outcome of interest groups' pressure on policymaker/regulators to keep the energy prices fixed.

In the panel analysis, energy prices were excluded; thus, the price rigidity of the energy prices was not analyzed. In addition, using the ABC model, price rigidity for a segment of the energy market—the gasoline retail market—was analyzed. The ABC model was used to test the state-dependent hypotheses of menu costs and inattentive producers, as well as the time-dependent hypotheses of political interference, regulatory capture, price regulation, and the political business cycle in the gasoline market. The hypotheses of political interference in the periods of pre-election and the regulatory capture of the Energy Fund and price regulation were supported for the period of 1990−2012. In contrast, the state-dependent hypothesis of menu costs and the hypothesis of inattentive producers were both rejected in the gasoline retail market in Curaçao.

Generally, consumers around the globe have been complaining about price asymmetric behavior of the producers in the gasoline markets. Price asymmetry in the gasoline retail market is caused by rockets and feathers (Bacon, 1991) or *inverse* rockets and feathers (Bacon and Kojima, 2010). The *inverse* rockets and feathers was confirmed in the period of 1990–2012 in the gasoline retail market in Curaçao. In the case of Curaçao, occasional price declines in the

international gasoline market were more likely to be immediately passed on through domestic prices than were common price increases. This may be ascribed to the political interference in the gasoline price setting in pre-election periods, when gasoline price increases were postponed despite the increase in the international gasoline prices, while the international gasoline price declines were passed through in the domestic gasoline prices.

Considering the fact that prices in Curaçao are sticky in the short run, it is interesting to know its impact on the long-run path of prices. For the long-run domestic price adjustments, the relative PPP hypothesis is used. Besides sticky prices, the high transportation costs on micro-islands may lead to deviation from the PPP. The relative PPP was tested with a sample consisting of selected Caribbean micro-islands. The relative PPP was rejected for two islands—Barbados and Dominica—out of the seven selected Caribbean micro-islands of Aruba, the Bahamas, Barbados, Curaçao, Dominica, Saint Kitts and Nevis, and Saint Lucia. The rejection of the relative PPP was due to the depreciation of their exchange rate. The results of the relative PPP hypothesis revealed that the sticky domestic prices and the high transportation costs in Curaçao did not lead to a rejection of this hypothesis. For the deviations from the PPP in Curaçao a nonlinear specification is applicable. A nonlinear specification is advised when there are transaction costs between the trading countries, which in this case entail the high transportation costs of micro-islands. The results of the PPP in the case of Saint Lucia revealed that having high transportation costs *does not necessarily* imply a nonlinear specification of the deviations from the PPP as proposed in the literature (Sarno, 2003, 2005). More specifically, the deviations from the PPP in Saint Lucia are presented by a linear specification.

Undoubtedly, more research is needed in field of sticky prices on micro-islands, which is a previously unexplored topic. The cost of sticky prices due to misallocation of resources and

the cost of economic distortion due to price asymmetry are interesting areas left for future research. Another important element that was not dealt with is the fact that the longstanding hypothesis of price flexibility in small economies conflicts with the finding of sticky prices in Curaçao. Hence, this theory needs fine tuning. In addition, other unexplored areas of research include price rigidity caused by the implicit contracts between the customer and the seller (Okun, 1981), fair pricing, concentration ratios, and tacit collusion. For research in these areas, more information is necessary. This brings up the topic of the incomplete or lack of data on the micro-islands. Immediate attention is needed to rectify this lack of data, as this leads to sample selection bias, which may result in incorrect interpretation of results and inadequate policy formulation for micro-islands.

Finally, sticky prices on micro-islands have not been previously discussed in the literature, and this topic is therefore a valuable addition to the existing research. Conceptually, sticky prices on a micro-island are a contradiction. Moreover, based on the available literature, sticky prices in Curaçao appears to be is a novelty. I propose the term “mañana” to designate the phenomenon of postponing price changes which causes sticky prices in Curaçao. *Mañana* literally means *tomorrow* and is an expression that is often used to refer to (the time lag involved in) the postponement of a task or a decision.

References to Chapter 7

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## Summary

This dissertation focused on explaining the price rigidity on a Caribbean micro-island. After an introductory description of price rigidity, a review the Caribbean micro-islands was presented in Chapter 2. These are small island developing states (SIDS), each with a population of less than half a million. The SIDS were recognized by the United Nations (UN) in 1992, as a distinct group of countries that share common development challenges. The common characteristic of smallness among SIDS implies small commodity markets with higher per unit costs of production than those of larger countries. In addition, because micro-islands are insular and small, their transportation costs are higher than those of larger countries. Consequently, a higher *price level* is expected on micro-islands.

Consistent with the "price-flexibility" hypothesis that assumes that prices in small economies (including micro-islands) are flexible, the *price changes* on micro-islands are expected to adjust in line with international price changes. Sticky prices on a micro-island, therefore, contradict the long-standing price-flexibility hypothesis, which is probably one of the reasons why a theory on this concept has not been considered. The empirical observation of sticky prices in Curaçao, therefore, raises the question of why prices adjust slowly on this Caribbean micro-island. This puzzle was the initial motive for pursuing this research. To the best of my knowledge, price rigidity on a micro-island is a topic that has not been previously considered in the literature.

The omission of this topic in the literature may be related to the fact that only recently, in 2011, were the first results on price frequency adjustments of micro-islands published by the Caribbean Centre for Money and Finance. The price frequency adjustment and the sizes of price adjustment are measured using the consumer price micro-data. Of the 24 Caribbean micro-

islands, only 3 reported their price adjustments. Barbados reported on the period of 1994−2008, Saint Lucia on 1984−2008, and Curaçao on 2006−2010. The price change frequencies reported were 50–80%, 98%, and 9%, respectively. A clear-cut benchmark to distinguish sticky from flexible prices is lacking in the literature. In this dissertation, the benchmark for frequency of price adjustment of less than 22% was considered sticky. Hence, the prices in Barbados and in Saint Lucia were flexible, while they were sticky in Curaçao.

As only these three micro-islands reported their price frequency adjustments, it remains unclear whether Curaçao is an exception in the group of micro-islands or whether there are other micro-islands with sticky prices. Even so, this possibly unique case of price stickiness on a micro-island requires an explanation. Hence, this dissertation explained the price rigidity in Curaçao by applying selected New Keynesian price rigidities' theories and the theories of political science.

New Keynesian price rigidity theories assume that markets do not clear and prices adjust sluggishly. There are many reasons stated in the various theories/hypotheses for why prices do not adjust instantaneously, including the state-dependent hypotheses of menu costs (Barro, 1972), attractive pricing (Levy et al., 2011), coordination failure (Blinder, 1994, 1998), and information delays (Reis, 2006), and the time-dependent hypotheses (Calvo, 1983; Taylor, 1980), implicit contracts, hypotheses of kinked demand, fair pricing, and tacit collusion. It is important to notice that these theories were developed in relative large markets and for a micro-island, a different approach may be required.

I also proposed a political angle to explain the price rigidity in Curaçao, namely the hypothesis of political interference in price setting, which states that the political intervention in price leads to price rigidity in Curaçao. Political interference consists of regulatory capture, the

political business cycle and price regulation in the price setting. Regulatory capture in price setting occurred in the period following the energy price hikes in 2005, when interest groups pressured policymakers to maintain the regulated energy prices fixed in times of price hikes. The political business cycle in price setting occurred when the incumbent policymakers abstained from raising the regulated energy prices in periods of pre-election, as this would jeopardize their chances of re-election.

I employed several methods to find out more about the frequencies and size of price adjustments in Curaçao. The methods applied in this dissertation were a descriptive analysis, a panel analysis, the autoregressive binomial conditional (ABC) models, linear co-integration, the nonlinear threshold autoregressive (TAR) models, and the exponential smooth transition autoregressive (ESTAR) models.

The descriptive analysis applied in Chapter 1 examines the theories of price rigidities from the perspective of the micro-island of Curaçao. The descriptive analysis was applied to investigate whether the price-rigidity theories may fit in the small commodity markets of Curaçao. The state-dependent hypotheses of menu costs, a price plan, and the staggered pricing hypothesis of coordination failure are not likely to occur in Curaçao. Menu costs, which are the cost of changing prices, are small and most likely negligible in Curaçao. The price plan, which is a plan of current and future prices, are not used in Curaçao. Coordination failure is not likely either as small island firms are more likely to cooperate.

Alternatively, the hypotheses of implicit contracts, fair pricing, tacit collusion, and attractive pricing are more likely to apply in Curaçao. Implicit contracts are based on informal business relationships, which are not uncommon in small communities. According to the fair pricing hypothesis, customers perceive a change in price after a demand shock as unfair, thereby

causing prices to remain unchanged. This hypothesis may apply, for example, in times of a hurricane warning when hurricane-proof building materials are in demand. Under such circumstances, price increases of these goods are considered unfair; consequently, prices will be kept unchanged and remain sticky. Tacit collusion is when firms tacitly cooperate in the price setting and/or the output level determination. As a result, prices may be sticky. As tacit collusion has been reported in the trade and construction sectors of Curaçao, it may be a source of price rigidity.

Chapter 3 analyzed the stylized facts of the CPI micro-data (excluding rental fees) of Curaçao in the period of 2006–2010. The data show that Curaçao has asymmetric, sticky downward prices. This finding is inconsistent with the kinked demand curve theory. In the kinked demand curve theory, oligopolistic firms cooperate only in price decreases, as opposed to the micro-data in Curaçao, where price increases were mostly reported. Other stylized facts are as follows: Price change frequencies varied from low to high across the sectors or were heterogeneous. Moreover, the duration of price spells, the period wherein prices remained unchanged, had an average duration of 10 months. In addition, in contrast to the asymmetrical price change frequencies, the sizes of price changes are almost symmetrical.

Chapter 4 used panel analyses to explain the price change frequencies and sizes in the period of 2006–2010. The price-rigidity hypotheses applied were attractive pricing, seasonality, and the political interference hypotheses (price regulation, regulatory capture, and political business cycle). The applicability of these hypotheses to Curaçao was tested.

Two panels of data were used, namely a panel of product categories (e.g., food, housing) and a second panel of types of commodities (e.g., non-durables, services). In addition to rental fees, the panel analyses also excluded the data of the energy sector, insurance, and postal

services. These excluded data were index data instead of prices. The reason for this exclusion was that the test of attractive pricing requires the last two digits of each price. The results showed that the attractive pricing hypothesis of 5 and 9 endings causing sticky prices was rejected in both panels. Alternatively, depending on the panel, seasonality in the months of January and February and political interference caused price rigidity in Curaçao.

The energy sector (including the gasoline retail market) was not included in the panel analysis. The hypotheses of price regulation, regulatory capture, and the political business cycle were tested in Chapter 5 to determine whether they explain the sticky prices in the gasoline retail market. Micro-islands are dependent on oil as a main source of energy, which needs to be imported, as most of these countries lack natural resources. Similar to other countries, gasoline is an important combustible on micro-islands. As a consequence, governments on micro-islands tend to intervene in gasoline prices when international oil prices soar. In the small, close-knit community of Curaçao, interest groups pressured the government in the period following the international oil price hikes in 2005 to maintain the energy prices. Apparently, the regulatory authority cooperated with the government and kept the energy prices fixed, revealing a case of regulatory capture. This resulted in the introduction of an "Energy Fund" to subsidize the energy prices during 2006−2007 period.

In pre-election periods, policymakers appeared to forestall "unpopular" decisions concerning gasoline price increases, representing a clear example of the workings of a political business cycle. Accordingly, gasoline price increases were postponed. Chapter 5 applied the ABC models to the gasoline retail sector in Curaçao in the period of 1990−2012. The alternative theories of menu costs, the inattentive producer and the political interference hypothesis are tested on the gasoline retail market in Curaçao with these ABC models. The hypothesis of

political interference was confirmed in most of the ABC models. The political interference in price-setting resulted in price rigidity. The hypotheses of menu costs and inattentive producers were rejected in the case of the gasoline retail market of Curaçao.

Similar to most countries, the gasoline prices in Curaçao are asymmetric. In contrast to most countries, the data of Curaçao show that the gasoline price declines were more likely to be passed through after occasional international gasoline price declines than after common international gasoline price increases.

Overall, prices were sticky for on average 10 months, thus prices are sticky in the short run. The impact of sticky prices on the long run prices is tested through the relative PPP. In Chapter 6, the relative PPP theory hypothesis assumes a long-run relationship between the adjustments in the domestic prices, the prices changes of the trading partner, and the exchange rate changes. The United States is the main trading partner of most of the Caribbean micro-islands, which have their currencies pegged to the US dollar. Hence, the relative PPP is about the long-run bilateral relations between the domestic prices and the US prices.

Besides sticky prices, the PPP may also fail due to high transportation costs, which is a common characteristic of the Caribbean micro-islands. To test the relative PPP, two approaches were applied, namely the linear approach of co-integration, the nonlinear TAR models (TAR), and the ESTAR models. The nonlinear approach (TAR or ESTAR) is recommendable, particularly when there are arbitrage costs, as in the case of high transportation costs in Caribbean micro-islands.

The test of the relative PPP hypothesis was used on a sample of selected Caribbean micro-islands based on data availability. The sample consisted of the islands of Aruba, the Bahamas, Barbados, Dominica, Curaçao, Saint Kitts & Nevis, and Saint Lucia in the period of

1990−2012. The results showed that the sticky domestic prices and high transportation costs of Curaçao did not lead to a rejection of the PPP hypothesis, and that the deviations of the PPP were estimated by an ESTAR model. The high transportation costs, which are a common characteristic of micro-islands, did not result in the overall rejection of the PPP hypothesis on the Caribbean micro-islands either, as the PPP hypothesis was rejected for only two out of seven islands. Remarkably, despite the high transportation costs of the micro-island of Saint Lucia, a linear specification was applicable to this island. This shows that the use of the nonlinear approach, which is often proposed when arbitrage costs are present, is not always necessary.

To summarize, this dissertation provided evidence of sticky prices on a Caribbean micro-island of Curaçao. Prices were found to be sticky in the short-run. SDP and TDP were tested to explain this price stickiness. The state-dependent price hypothesis of attractive prices was rejected as a source of price stickiness. TDP by political interference (the political business cycle, regulatory capture, and price regulation) and seasonality explain the price rigidity in Curaçao. Contrary to expectations, the sticky prices in Curaçao did not have an impact on the long-run prices. Hence, the long-run PPP holds for Curaçao, the micro-island with sticky prices.

**List of Interviews, Letters, and Email**


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   Jamir Barton is a consultant of price regulation working for the Department of Economic Affairs, "Dienst Economische Zaken"
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   Dimitri Cloose works as a staff member at the Curaçao Ports Authority N.V.
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   Joel Gois is the former president of the Supermarket Association, SUVECU.
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   Tyronne Magloire is a staff member of the Department of Economic Affairs. He specializes in price regulation.
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   Dianadira Martis works at the Central Bureau of Statistics Curaçao. The data are from the National Accounts 2011–2012.
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    Edil Paulina is the director of the sister company of the Curoil N.V., the Curgas N.V. The Curgas distributes the cooking gas to households and the companies. He is a former staff member of Curoil
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    Stella van Rijn is the former director of the contractors' association, the "Antilliaanse Aannemers Vereniging"


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